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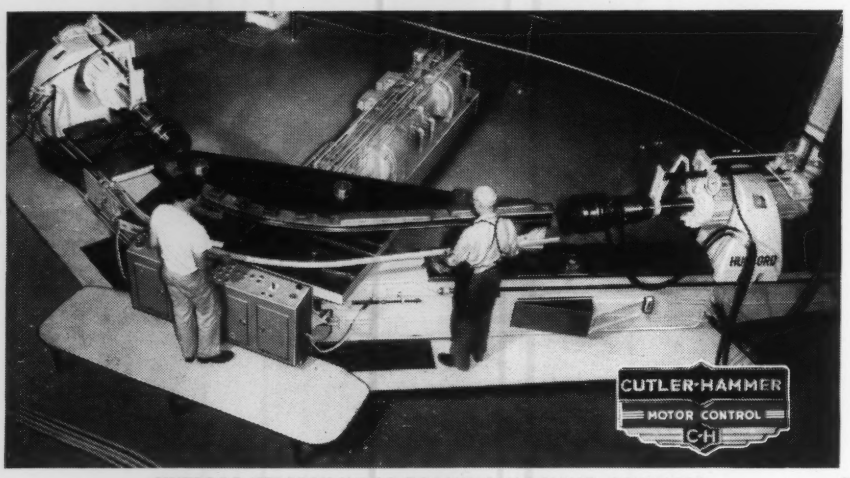

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MACHINE DESIGN

THE PROFESSIONAL JOURNAL FOR CHIEF ENGINEERS AND DESIGNERS

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Over the Board

Low-down on High-brows

One of the most popular regular features in MACHINE DESIGN is the *Design Abstracts* department, which has been running continuously since 1942. Here you will find selected portions of papers presented at engineering association meetings, the selection being based on the particular interests of design engineers. Your response to this section has encouraged us in recent months to expand our coverage and to include longer portions of outstanding papers. For example, the "lead" item in this month's issue, Page 177, presents an unusually clear and concise discussion of the place of modern computing machines in engineering calculation. We hope you agree with us that it brings a high-brow subject down reasonably close to earth.

This Month's Cover

A departure from the series of artist's paintings which have graced our front covers since the beginning of the year, this month's cover was made from a Kodachrome photograph showing a group of design engineers studying the "know-how" of design for production. The scene illustrates the Van Hamersveld-Beery article, "Investment in Know-How" which begins on Page 114 and was taken in the plant of Northrop Aircraft, who kindly furnished the original transparency. Incidentally, John Van Hamersveld, who has authored previous articles in MACHINE DESIGN, appears in the photo, standing at the extreme left of the picture.

Bafflegab

The old "gobbledegook" of early New Deal days has given way to a streamlined version known as "bafflegab." Those in touch with the "ulcer gulch" of the Potomac (and who isn't, these days?) will recognize this definition as an apt example of the lingo employed by its inhabitants:

> Bafflegab is multiloquence characterized by consummate interfusion of circumlocution or periphrasis, inscrutability, incognizability, and other familiar manifestations of abstruse expatiation commonly utilized for promulgations implementing Procrustean determinations by governmental bodies.

This definition is by newspaperman Milton A. Smith, who is credited with coining the word.

Contents Page

The page preceding this one now appears in a new guise. Conscious of a need to tell a little more about each article than the bare title would indicate, we are supplementing the titles with explanatory "decks" which we hope you will find helpful. In order to make room for the extra wording we have transferred the editorial and business staff listings (the "masthead") to this page.

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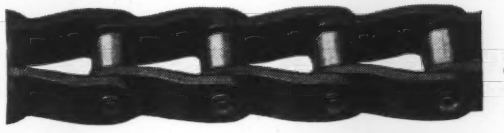
granted?

● In another instance, a Rex Field Sales Engineer persuaded a manufacturer to switch from the pin-and-cotter roller chain he was using to a Baldwin-Rex Riveted Roller Chain. The change not only resulted in an initial cost saving but in longer life since the rivets have greater holding power.

● To a manufacturer of construction machinery, who had been using cast manganese steel chains, a Rex Field Sales Engineer recommended the use of Rex Steel Chabelco Chains.  Since these chains are designed for efficient operation under dusty, dirty conditions, longer service life for both chains and sprockets at lower overall costs resulted.

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MACHINE DESIGN **TOPICS**

. . . IN ENGINEERING AND RESEARCH

Racing Car Has Off-Center Drive

The entire drive line in the six-cylinder diesel race car built by Cummins Engine Co. for the 1952 Indianapolis 500-mile race has been shifted to the left side of the car. Main purpose of the novel off-center drive is to curb excessive tire wear on the right front wheel during the recurrent left turns around the Speedway. A lower center of gravity is also possible, since the driver, instead of straddling the transmission, sits much lower in the chassis.

Synthetic Lubricants Made from Turpentine

Pinic acid, derived from turpentine, is the major constituent of a new series of synthetic lubricants developed for aircraft gas-turbine engines, instruments and hydraulic systems by the Department of Agriculture and the Navy. The acid, oxidized from alpha pinene obtained from turpentine, is combined with high-boiling alcohols to form oils or greases, which can then be used alone or mixed with other synthetic lubricants or mineral oils.

Rocket Propellant Used for Tuberculosis Treatment

Hydrazine, a chemical compound that shows promise as a rocket propellant, is also an essential part of a new family of antituberculosis drugs. Many TB cases which appeared to be hopeless have shown improvement, although the drugs are not yet considered a cure. As a result the Ordnance Corps, the only large-scale manufacturer of hydrazine, is deferring delivery to Army rocket research programs in order to channel the compound into commercial areas for clinical tests.

Radiation Detector Has 10 Million to One Range

Nuclear radiation intensity varying from 0.1-milliroentgen to 1000 roentgen —a range of 10,000,000 to 1—can be rapidly read from a single scale on a new, small-size radiation detector. Earlier detectors have required a switching arrangement to change scales when measuring wide ranges of radiation intensity. Developed at the Armour Research Foundation, the new instrument is no longer than the average table-model home radio.

Pulse Jets Power One-Man Helicopter

Two 16-pound pulse jet engines mounted on the ends of the two rotor blades power a miniature one-man helicopter developed by the Army Ordnance Corp. Weight of the XH-26 is only 300 pounds, and height is only 6 feet. Total flight time is 90 minutes, with gasoline, kerosene or diesel oil as fuel. Capable of being collapsed into a 5 by 5 by 14-foot container, the helicopter can be unpacked and put in the air in about 20 minutes.

Steam "Slingshot" Catapults Jet Fighters

Having enough power to sling a jet fighter into the air even when the ship is headed downwind, a steam catapult will be installed on the air-

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TOPICS

craft carrier *Hancock* in 1954. A hook on the aircraft to be launched is connected through a slot in the catapult cylinder to the piston. High-pressure steam from the ship's boilers provides launching power, and a specially developed sealing device prevents steam from escaping through the cylinder slot.

Battery Powers Wrist Watch

A miniature motor replaces the mainspring and winding mechanism of an experimental battery-powered wrist watch developed by the Elgin National Watch Co. The battery and motor, said to be the smallest practical units of their kind ever made, are expected to run more than a year before the battery needs to be replaced.

"Pencil" Diode Tube Is Smaller than Cigarette

Measuring less than ¼-inch in diameter and a fraction more than 2 inches in length, a new RCA Victor diode tube is smaller than a cigarette and weighs less than 1/5 ounce. Similar to triode types formerly announced, the new tube can be used for pulse detection and pulse power-measuring service at frequencies up to 3300 megacycles per second.

Locomotive Adjusts to Track Gage

Simple mechanical adjustment of the wheels on the axles permits a new diesel locomotive built by General Motors for the Army to run on tracks of varying gage, from U. S. Standard to the widest in use. The engine can also be fitted with couplers of any type used. The power plant, a 16-cylinder, two-cycle diesel which can use 40 cetane fuel oil or lower, is rated at 1600 horsepower. Capable of a top speed of 77 mph, the locomotive is designed to operate in temperature extremes of −40 F to +125 F.

. . . IN GOVERNMENT AND INDUSTRY

Metal Production Per Capita Increases

Domestic production of raw steel and six leading nonferrous metal products was about 1425 pounds per person in 1951, an increase of 84 pounds over 1950. Actually, according to AISI, steel production per capita increased 86 pounds, while nonferrous metal products dropped 2 pounds. Among the nonferrous metals, magnesium wrought and cast products showed the biggest gain, with slab zinc and aluminum wrought and cast products registering smaller increases.

NPA Authorizes Official Interpretations

In order to provide a clear understanding of official views and decisions on orders, regulations, amendments, directives and schedules, the National Production Authority has issued Regulation No. 7 which governs the issuance of authorized interpretations. Interpretations of general interest will be published in the *Federal Register,* while interpretations regarding a specific operation or transaction will not be published. No hypothetical questions will be answered, and interpretations not issued in accordance with the directive will not be considered legally binding.

Industry . . . Largest Scientific Instrument Buyer

Industrial customers bought 50 per cent of the scientific instruments and laboratory apparatus and equipment sold in the United States last year, according to the Scientific Apparatus Manufacturers Association. Formerly the largest single customer group, educational institutions accounted for 23 per cent during the year. Federal, state and local government agencies took 12 per cent, hospitals 5½ per cent, export 6½ per cent, and miscellaneous 3 per cent.

Confusion and Cuss-Words

THE story is told of a quartet of college boys on a cross-country automobile trip who had the misfortune to experience a flat tire. As the group stood helplessly by the roadside one of the youngsters was heard to remark: "I wish my Dad were here; he knows how to change a tire."

A slightly ridiculous commentary on this age of specialization? Perhaps, but how would Joe the design engineer fare if suddenly confronted with the task of, let us say, completely machining a rough casting to close tolerances? Chances are that he too would fumble around and wish his Dad were there.

His Dad is a designer too, but he came up through the shop instead of straight from college. He may be short on science and mathematics but he has a "feel" for machinery and a know-how of shop practice that enables him to design parts with a sure knowledge that they can be made at reasonable cost and without too much difficulty.

At the age of life when Dad was working as a mechanic in the shop, his son was acquiring an education in engineering fundamentals that enables *him* to design mechanisms and machines with confidence that they will perform their task efficiently and not fall apart.

If Dad could stick around long enough the two would make an execellent team, each supplementing the other's know-how. But that is not to be, so tomorrow's designs will be in the hands of Joe and his college-trained contemporaries.

How is Joe to acquire the practical know-how that his Dad possessed? Not by working in the shop for half a dozen years after graduation—his engineering skill is too badly needed right now.

The question has plagued engineering management for a long time, and it is therefore with considerable satisfaction that we present in this issue the practical answer that one imaginative company has worked out. Northrop Aircraft's "investment in know-how" is already paying off dividends in more practical, economical designs, to say nothing of the improved human relationships resulting from personal acquaintance with shop men and an understanding of their problems. As the authors have put it, "complexities in design stand out as confusion and cuss-words." There will always be cuss-words in the shop, but fewer of them could be directed against the design engineers.

Colin Carmichael

EDITOR

By John Van Hamersveld and D. C. Beery
Supervisor *Ass't. Supervisor*
Producibility Engineering
Northrop Aircraft, Inc.
Hawthorne, Calif.

INVESTMENT IN "KNOW-HOW"

Shop familiarization course for engineers and designers pays big dividends in more effective designs and manufacturing economy

FUNDAMENTALLY, designs with inherent production difficulties can eventually be fabricated by the development of new machines, techniques and manufacturing processes. Such may be necessary at times, but in the majority of cases designs must be adapted to utilize available facilities to best advantage, the aim being toward simplified designs co-ordinated with the most economical method of manufacture. Achievement of this co-ordination demands a high degree of design skill which necessitates constant development by keeping designers abreast of latest manufacturing techniques.

With these thoughts in mind, the producibility engineering section of Northrop Aircraft organized a course in shop familiarization for their engineers, *Fig.* 1. This familiarization program was to be directed toward expanding the engineers' potential knowledge with the end result of more efficient design practices. It was of prime importance to obtain a higher degree of productivity to assist in meeting tight design schedules. Need for such a course was further emphasized by the present-day difficulties in obtaining qualified production-conscious engineers.

Aims and Purposes: It is well known, of course, that successful production is dependent to a considerable extent upon close co-ordination between engineering and other company divisions. Thus, one of the fundamentals in pursuing improved design practices is study of the problem of inertia friction between manufacturing and engineering. A paramount aim of this course, therefore, is to develop a feeling of personal acquaintance not only with the machines in the manufacturing departments, but with the men as well. The men in the other divisions then become personalities rather than "so-and-so's" in the shop and the machines can be visualized as specific equipment instead of a mental image of a word.

Respect instilled for the skills and the abilities of men in the shop becomes a valuable asset to the engineers. Close tolerances become sweat and painstaking effort rather than a question of cold figures; access problems become sore fingers or strained muscles; and complexities in design stand out as confusion and cuss words.

Basic Concepts: Engineering experience implies years of work and study varying with each individual. It results in a relatively corresponding amount of design know-how. Therefore, the aim of an improvement program is to provide, as rapidly as possible, a maximum degree of know-how. To achieve this, the program should emphasize the following:

1. Acquaintance with all manufacturing facilities
2. Evolvement of proper type of design information necessary to facilitate design effort
3. Sharpening of the ability to visualize how designs are fabricated
4. Encouragement of mutual respect between manufacturing and engineering in solving problems
5. Development of the communication of thoughts and ideas between design and manufacturing departments
6. Creation of a *feel* for shop problems by personal

Fig. 1 — Left — Engineers observe operation of longitudinal saw during shop familiarization course

Fig. 2 — Below — Listing showing typical breakdown of tours employed in familiarization course

SHOP FAMILIARIZATION COURSE #110

1st TOUR — January 21, 22, 23 & 24, 1952
Loft and template
Wood shop
Plaster shop
Foundry

2nd TOUR — January 28, 29, 30 & 31
Sheet metal fabrication
Extrusion forming
Heat treating

3rd TOUR — February 4, 5, 6 & 7
Machine shop

4th TOUR — February 11, 12, 13 & 14
Tool and die shop
Assembly jig fabrication

5th TOUR — February 18, 19, 20 & 21
Welding shop

6th TOUR — February 25, 26, 27 & 28
Paint shop & metal processing
Spotweld
Cable assembly

7th TOUR — March 3, 4, 5 & 6
Plumbing hydraulic
Engine sub-assembly
Electrical

8th TOUR — March 10, 11, 12 & 13
Plastic shop

9th TOUR — March 17, 18, 19 & 20
Final assembly
Flashweld

10th MEETING — March 26
All (4) classes combined, dinner, discussion & distribution of diplomas.

Classes will be conducted from 6:00 P.M. to 8:00 P.M. on the dates noted.

Each class will consist of a ten minute familiarization lecture beginning at 6:00 P.M. in the Photographic Laboratory Conference Room followed by a tour through the departments as scheduled.

contact, discussions with manufacturing personnel and the actual operation of various pieces of equipment.

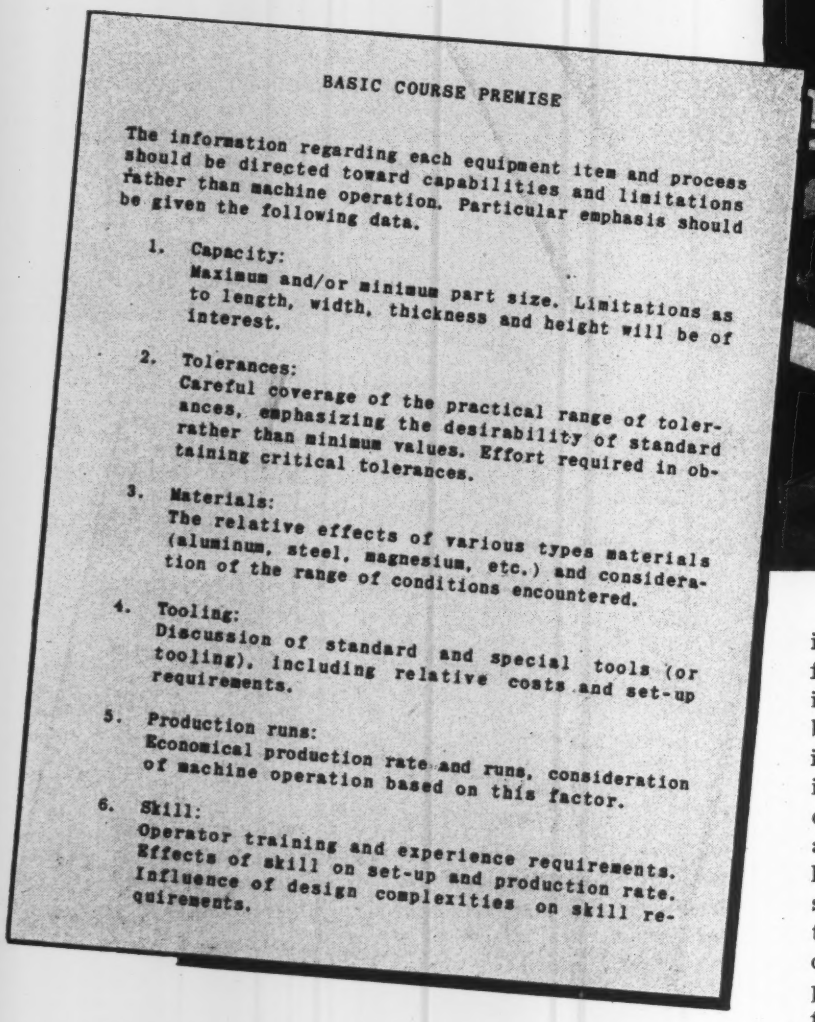
Fulfillment of these basic concepts should give each man the feeling that he has gained in know-how; that he has personally experienced something significant that should be retained for use at every opportunity.

Preplanning of Scope: In the first phase of planning this shop familiarization course, a cursory examination was made of the manufacturing facilities to determine how the various departments could be correlated into a series of tour units. At this time it was also necessary in the arrangement of the tour program to consider which departments would have the maximum effect on engineering design. A typical tour breakdown is shown in *Fig.* 2. It was determined that covering these departments at Northrop would provide a satisfactory tour of the plant facilities.

To ensure that this course would not become an instruction in machine operation, a basic premise of design philosophy was developed and became the foundation of information for each tour, *Fig.* 3. This premise assisted greatly in promoting a constructive type of discussion between manufacturing and engineering personnel and in preventing the course from becoming a series of bickering complaints. In addition to this format of design philosophy, a touch of showmanship is achieved by providing workplace exhibits of various types of parts fabricated in each shop section. This assists in maintaining interest and serves as excellent discussion material. In *Fig.* 4 is a typical tour exhibit showing parts produced in the plastics department.

In developing a sense of feel and know-how, it is most essential to set up equipment so that the engineer may have the opportunity of actually producing a part, *Fig.* 5. This creates a pride in the realization of carrying out the whole sequence of design to man-

Fig. 3—Basic design philosophy around which information from tours developed



BASIC COURSE PREMISE

The information regarding each equipment item and process should be directed toward capabilities and limitations rather than machine operation. Particular emphasis should be given the following data.

1. Capacity:
   Maximum and/or minimum part size. Limitations as to length, width, thickness and height will be of interest.

2. Tolerances:
   Careful coverage of the practical range of tolerances, emphasizing the desirability of standard rather than minimum values. Effort required in obtaining critical tolerances.

3. Materials:
   The relative effects of various types materials (aluminum, steel, magnesium, etc.) and consideration of the range of conditions encountered.

4. Tooling:
   Discussion of standard and special tools (or tooling), including relative costs and set-up requirements.

5. Production runs:
   Economical production rate and runs, consideration of machine operation based on this factor.

6. Skill:
   Operator training and experience requirements.
   Effects of skill on set-up and production rate.
   Influence of design complexities on skill requirements.

ufacturing. Safety precautions are important since the engineer is not a skilled operator, but these facilities can be provided in the course by careful consideration of the equipment used.

Planning the second phase involved the presentation of the foregoing ideas to the manufacturing division for their consideration. The paramount success of a shop familiarization course depends upon the complete co-operation of this division which carries the brunt of the detail load in providing the facilities and instructors.

The manufacturing division was immediately aware of the potential benefits that could be derived in such a program. First, and probably the most valuable, was to have the engineers become interested in shop problems; second, was an opportunity to present their information to the engineers personally; third, was the future benefits when the engineers return to the drafting board and design for their facilities.

One of the important steps in organizing their part of the program was for the shop to establish a manufacturing co-ordinator who had the full authority to choose and orient the departmental instructors for each tour. His major function was to assist the instructors in developing their program around the basic design philosophies presented by the engineering division. Selection of the proper type of shop instructors is of major importance since they are required to have the ability to instruct the engineers in an interesting manner as well as to impart a thorough knowledge of their department facilities. As a result of these broad requirements, most of the instructors were chosen from the supervisory levels of each department. In order to prevent interference with production schedules, these men were chosen from the day shift and could then devote their complete time to the job at hand, since the course took place after engineering hours.

The manufacturing co-ordinator and the instructors prepared a general outline of each section of the course, *Fig.* 6. These outlines were then co-ordinated with the engineering division. In the course of the discussion that followed, it was mutually agreed that there should be tour captains from engineering. Their purpose was to assist the instructors in guiding the discussions and controlling the time sequence to assure the complete program coverage of each tour unit. The engineering tour captains were production-design engineers with both engineering and manufacturing backgrounds. With this type of background they were proficient in assisting the instructors throughout the program. These men met with the shop instructors, in the planning phase, to discuss flow pattern, parts exhibits and machine setup for each department.

During this period of co-ordination the problem of class size became apparent in the study of facilities, distances to be covered, type of transportation, fatigue, and most important of all, the noise level

Fig. 4—Left—Exhibit of parts manufactured in the plastics department as used for tour discussions

Fig. 5—Left—Engineers actually producing drop-hammer parts during shop familiarization course

Fig. 6—Below—Outline for welding shop tour is typical of those developed for each department

SEQUENCE AND DATA OUTLINE
OF WELDING SHOP TOUR

Production order
- Engineering blue print
- Detail instructions

Materials (Parent metals commonly welded at Northrop)
- Steel
  - Carbon alloy steels (chrome molybdenum)
  - Low carbon steels
- Corrosion resistant steel
- Aluminum
- Magnesium

Welding materials
- Steel
- Stainless steel
- Aluminum
- Magnesium
- Electrodes
  - Coated steel
  - Carbon
  - Tungsten

Gases
- Acetylene
- Oxygen
- Helium
- Argon
- Hydrogen

Welding equipment
- Electric arc machine
- High frequency arc machine
- Heliarc machine
- Gas torch

Welding preparation
- Metal surface
  - Clean
  - Etch
- Metal fitting - trim

Assembled detail parts
- Welding jigs
- Clamp
- Tack weld

Welding - Specific type and application
- Electric arc - Steel
- Gas torch
  - Steel
  - Aluminum
- Heliarc
  - Corrosion resistant steel
  - Magnesium
- High frequency arc - Aluminum

of the manufacturing departments. In addition to these problems, it was also necessary to consider the interest displayed by the engineers in attending these classes. It was estimated that a total of several hundred people would be involved and that the class size should be the maximum practicable. To obtain the optimum number of classes, it was determined that, considering all limitations, the class should be held to a total of fifteen men per tour, provided a satisfactory sound system could be obtained.

The final phase in planning the course involved the integration of the individual tours into a smooth flow-pattern by staging a "dry-run" composed of all shop instructors, co-ordinators and the tour captains, *Fig.* 7. The purpose of the dry-run (with each instructor discussing his own tour operations and the other instructors as students) was to establish the unification necessary to set the proper tempo for the program.

Public Address System: Need for an amplifying sound system in a course of this nature cannot be overemphasized. Inability of any of the class to hear is disastrous; attentions wander and only a few get the continuity of the discussion.

There are several significant factors to be considered in providing such an amplification system: volume, portability, self-contained power, and directionalism. The necessity for a battery operated set was established early in the investigation. It was felt that the problem of long wires and available outlets would render an ac set too cumbersome and impair the mobility of the tour. The search was then for a set of sufficient power to provide the necessary volume and portability. To make it really difficult, compactness was desirable.

The possibilities of finding equipment which met all requirements were, of course, remote. When the weight requirement was met, the power was not sufficient. Units with sufficient power were far too heavy. A shortage of time finally forced an ingenious solution. Two war-surplus Navy bull-horns were purchased and turned over to the electronics test laboratory for rework. The results were eminently satisfactory and the final unit appeared as illustrated in *Fig.* 8. Modifications involved detachment of the microphone from the horn and replacement with a separate hand mike. The horn was bracketed to the amplifier case in a convenient manner. Revision of the amplifier circuit was necessary to boost the volume output approximately 50 per cent. With these changes the units combined all of the desired features.

Increasing the output resulted in a corresponding increase in battery drain, reducing battery life to about six hours. This was considered minor in relation to the advantages gained. The volume was such as to permit hearing within a 60-degree cone over a range of 30 feet in any department. The hand microphone has a self-contained switch actuated by the instructor. The warm-up time is a fraction of a second, so that no appreciable wait is required. In use, the speaker unit is placed in a predetermined location for each machine or operation. This was found to be necessary because of the feed-back problem.

Engineering Enrollment: Announcement of this

course as a part of the Northrop engineering educational program aroused such enthusiastic interest that it eliminated any thought of setting up this program on a mandatory basis. It was realized, however, that a system of selection should be established to reach a balance between supervisory personnel, designers, and draftsmen. This was necessary because the draftsman and designer, having gone through this course, could conceivably cause embarrassment to their immediate superiors by virtue of their more intimate detailed knowledge of shop techniques and problems. In fact, it is most advisable that top engineering management also take this course to promote harmonious thinking throughout the engineering organization.

A quota was established for each engineering section, i.e., wing, body, hydraulics, etc., and the voluntary applications were presented to the individual supervisors. It was their prerogative to determine the proper balance for their personnel.

The success of the first tours was apparent in the flood of applications that followed and the present backlog is such that several more series are definitely planned. The response emphasized again that the benefit of showmanship in promoting the interest of each class is an important element in this type of training program.

Course Presentation: Successful planning efforts were immediately measurable with the completion of the first tour. However, the improvement of the presentation is a never-ending process, involving a great number of minor items which arise as the course develops.

It was apparent, early in the course, that those tours which involved several uninhibited individuals with large "bumps of curiosity" were the most interesting and successful. When the burden of query and reply was carried only by the tour captain and the shop instructor, the interest of the whole group declined considerably. Further presentations of the course involved a more careful distribution of the personnel to improve this factor.

The value of tour captains was reflected in many ways. Perhaps the greatest benefits were in time coordination and in the prevention of prolonged discussions of side issues. Since the engineers in attendance represent a cross-section of the engineering division, coverage of the tour must be kept as broad as possible and prolonged discussion of details avoided. At the start of each session the tour captains devoted approximately ten minutes to a preliminary discussion outlining the high spots of the evening's program. During this discussion they had the opportunity to point out the desired design information relating to the type of equipment that would be studied. Having a thorough understanding of the course premise, the tour captains are the motivating force behind the smooth and continuous flow of the entire program.

The necessity of portability and ample volume in the PA system was demonstrated many times over. The ability for all to hear eliminated wandering and loss of interest. In several departments the use of the system "on the move" enabled a wider coverage of the plant facilities, *Fig.* 9.

Some cases of "mike fright" which developed during the first presentation were eliminated by arranging private practice sessions before further tours. Instruction in microphone technique and practice to breed familiarity, usually resulted in more confidence and better delivery.

A two-hour duration for each tour proved to be the maximum from a point of fatigue and interest. The physical reaction to fatigue began to show toward the end of each tour and stimulation of the

Fig. 7—Thorough planning of tours by all instructors co-ordinators and tour captains is a must for success

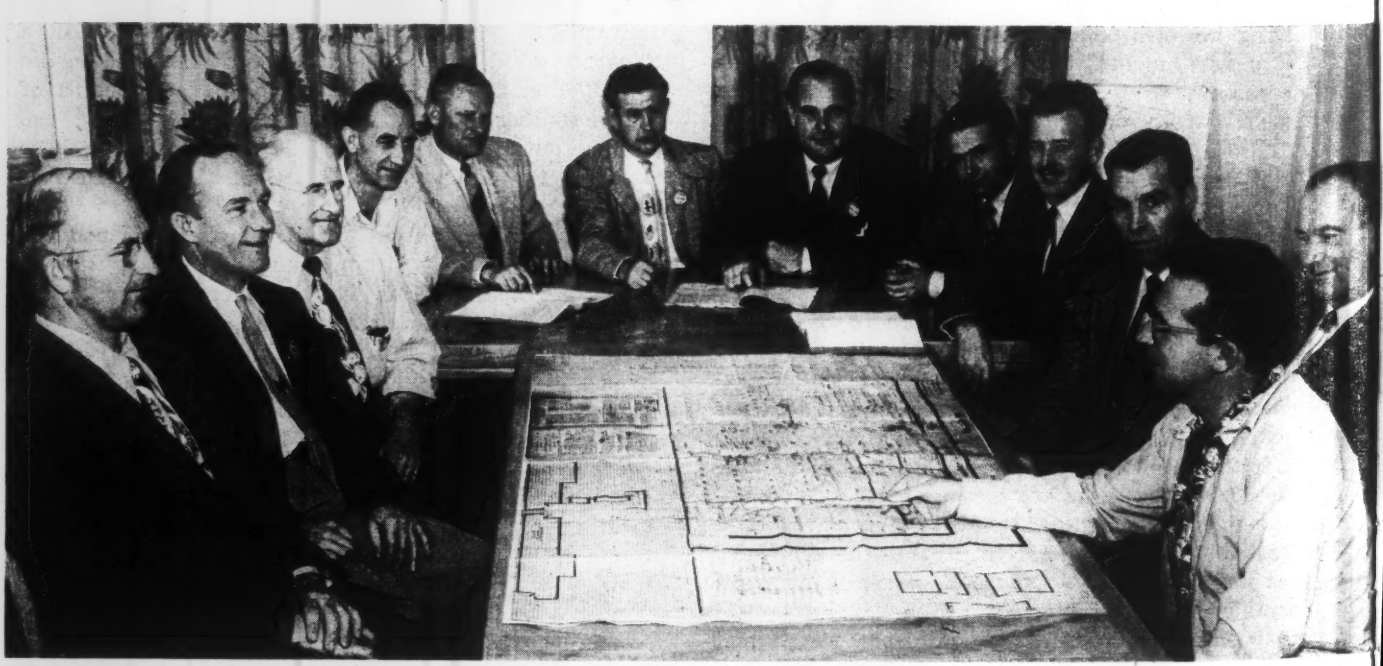
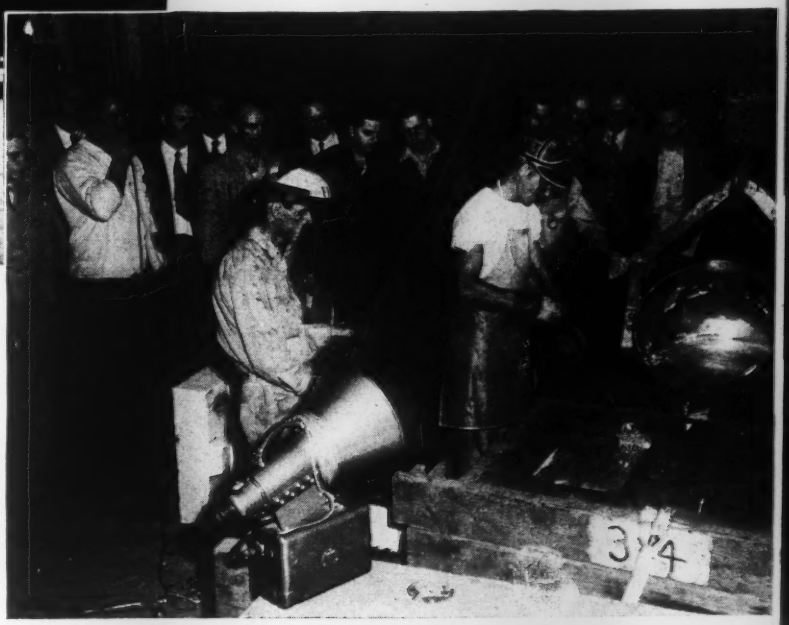


Fig. 8—Left—Close-up view showing the portable sound system designed for the shop course

Fig. 9—Below—"On the move" discussion showing class studying a casting operation



group's interest required more effort from the tour guide and instructor.

The last tour session, arranged as a dinner meeting, was attended by representatives of top management, who reviewed the course benefits to the company. This final touch of showmanship, indicating the sincerity of management, concluded with the presentation of graduation diplomas and a warm hand clasp.

Evaluating Results: The primary question asked by engineering and factory management was, "Have we achieved the basic know-how toward which this course was aimed?" The answer is in the evaluation of the apparent results as summarized in the following:

1. A definite trend toward production economy in engineering thinking as indicated by the increased number of open discussions bearing on the subject among designers
2. A noticeable improvement in the appreciation of co-ordination between divisions, borne out by a more receptive attitude in establishing compromises which constantly arise during the evolutionary stages of design and production
3. A clearer concept among the engineers of the important part they play in the development of economical production, and the recognition that their embryonic ideas in design start the manufacturing sequence
4. A realization was attained that deviation from productive thinking in design was reflected by serious difficulty in producing the part
5. Favorable reactions from manufacturing and tooling personnel in the mutual solution of production problems, indicating a progressive attitude toward eliminating the friction that often exists between various divisions.

It is anticipated that a future potential is still to be derived through this training course. As the engineer begins to put this know-how to use and to think about what he has personally experienced, several resultant factors become apparent:

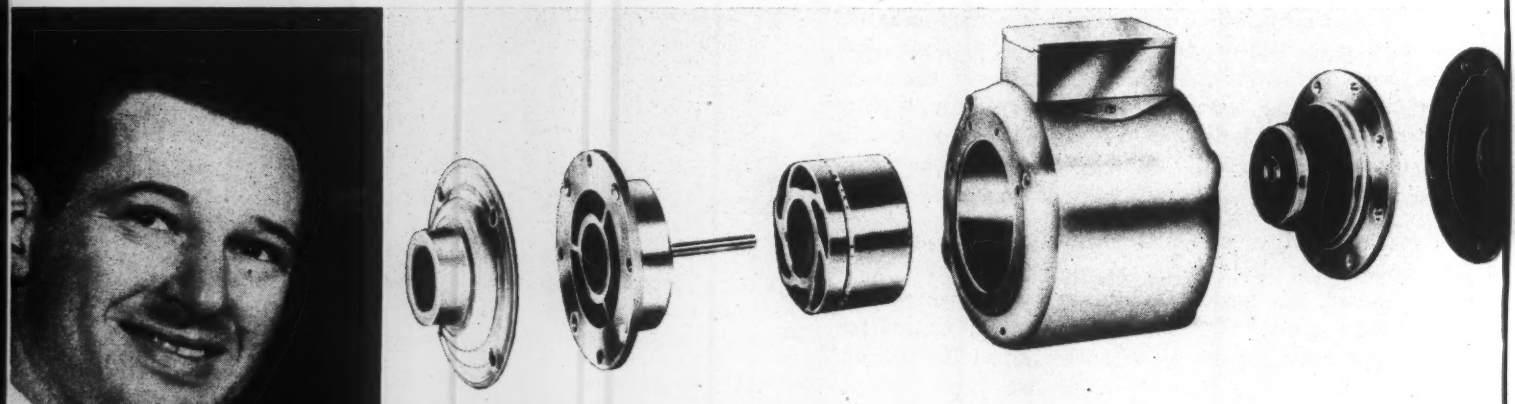
1. More competent engineering of smaller details, permitting concentration of effort on more complex and critical requirements
2. Need for follow-up programs in shop familiarization to keep the engineers up-to-date with the development of new techniques, equipment and design information
3. Motivation of a competitive spirit that is vitaliy necessary in today's industry to conceive producible designs
4. Understanding of colloquial terminology in rubbing elbows with tooling, manufacturing and producibility consultants
5. Reduction in design time by a more comprehensive knowledge of plant facilities
6. Better blending of theory and practice for more effective designs, resulting in less manufacturing hours and improved overall productive efficiency.

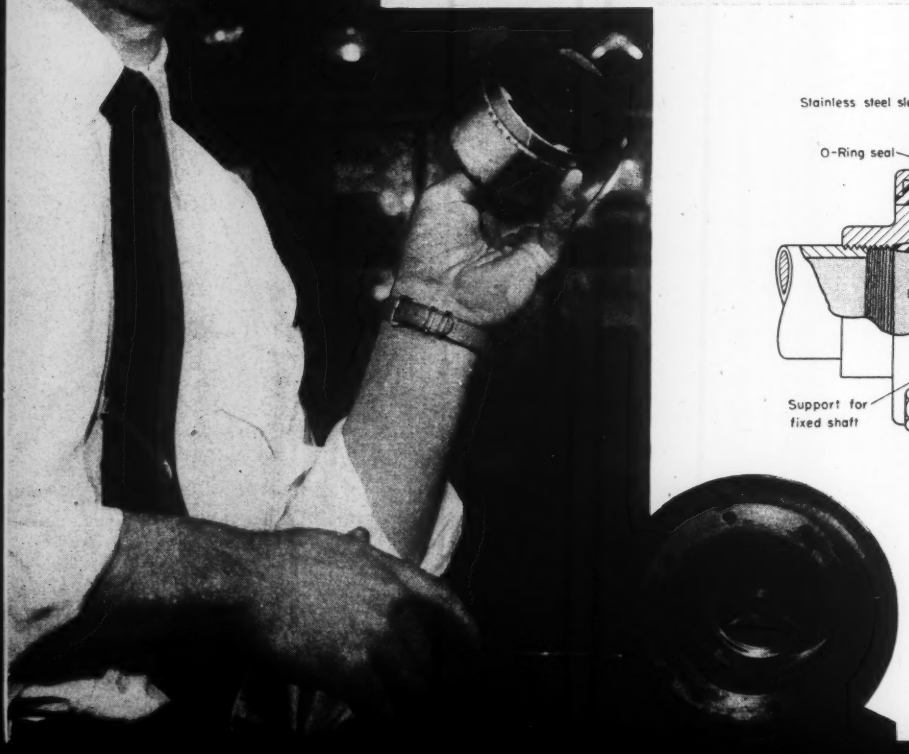
Management has accepted this program as a valuable assistance in solving manpower problems. The effects are not limited to the engineering division but are reflected throughout the company. Planned training of this magnitude requires a substantial budget outlay but the interest on every dollar invested in know-how is compounded again and again.

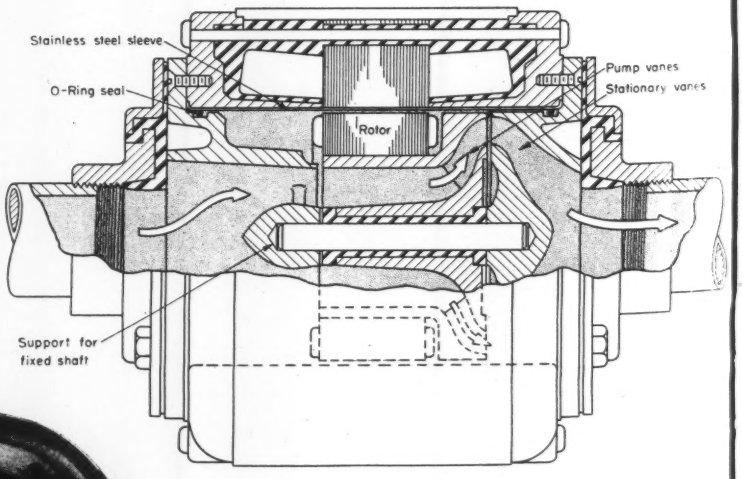
SCANNING the Field For Ideas

Novel motor-pump, below, utilizes the core of an electric-motor rotor as a pump impeller. Designed with a stub shaft so that all rotating parts are within the pump housing, the only seals required are static types and all problems associated with leakage from wear are thus eliminated. Because the rotor in a squirrel-cage motor requires no electrical contacts, it may rotate in the fluid being pumped and serve as an impeller. The motor stator, however, must be sealed from the pump chamber. This is effected through the use of a nonmagnetic stainless steel sleeve placed in the cylindrical air gap between the rotor and stator as shown in the photographs and sectional drawing.

For electrical efficiency and mechanical convenience, the air gap is usually less than 0.015-inch. If opened to 0.020-inch only a slight loss of efficiency is experienced. These figures establish that the thickness of the cylindrical barrier should not be greater than 0.010-inch. Only stainless steel and titanium meet the mechanical and electrical requirements for this sleeve. Among the stainless steels, type 347 ap-







peared to be best but 304 and 302 also have suitable characteristics.

To meet the close tolerances required the sleeve is butt welded from stainless strip. Assembly of this pump-motor, designed by Magnaflow Pump Corp., is shown in the sectional drawing. Before assembling, the stator is completely filled with a heat-resistant solid dielectric. The bore is machined and honed to tolerance. Then the sleeve is force fitted into the bore and the edges hermetically sealed over the edge of the end bells.

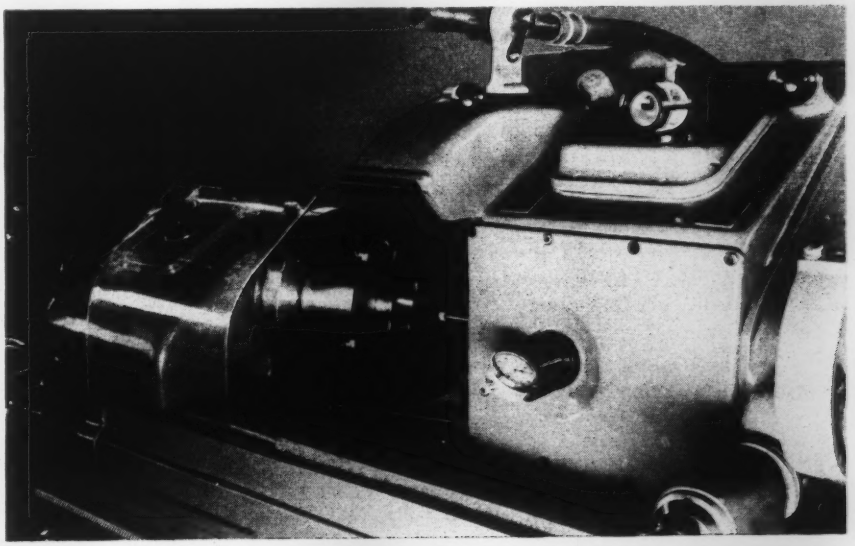
The intake and discharge manifolds support the stationary stub shaft. The rotor, which has carbon-graphite bearings, rotates on this shaft. Pipe flanges are incorporated in the end bells and serve as inlet and outlet for the straight through flow of the pumped fluid.

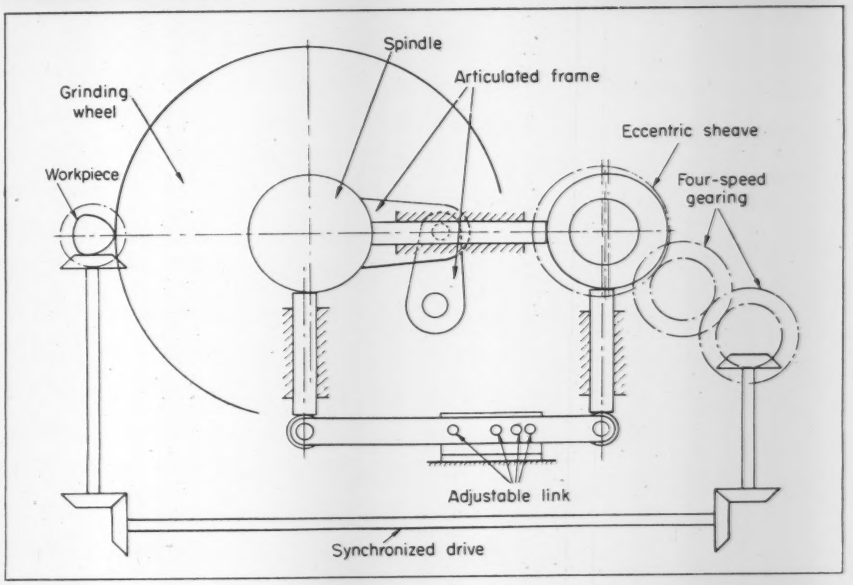
Capacity of the pump and its efficiency are limited by the sectional area available for fluid flow through the rotor because of the need for magnetic materials in the motor. For these reasons the design is limited to relatively small pumps such as employed in circulating systems, etc. In the design of larger pumps it appears that pancake motors of the axial-air-gap type may be utilized similarly to obviate shaft seals. In this case, however, the stainless steel barrier would be a disk instead of a cylinder, providing a static seal between the stator pump chamber.

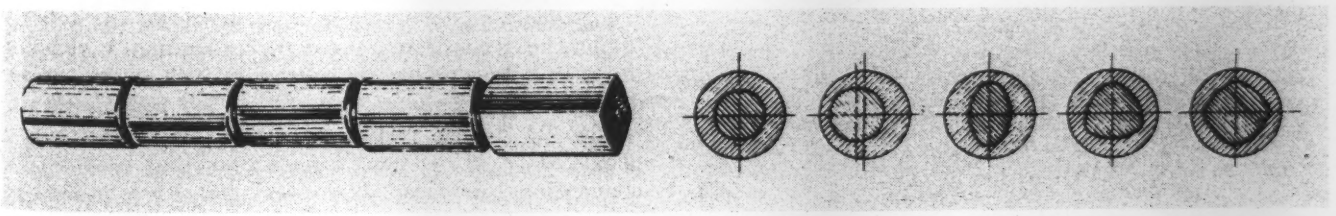
Circular eccentrics, elliptical eccentrics, triangles, or squares—either internal or external—are ground in a single setup with the machine illustrated at right. Designed by the French firm, Manufacture de Machines du Haut-Rhin, the machine employs two pistons and linkages as shown in the drawing at right to position the grinding wheel and generate the desired shape. While the movement of the horizontal piston is direct, the vertical piston movement is multiplied through an adjustable linkage, giving ratios of 1:1, 1:2, 1:3 and 1:4.

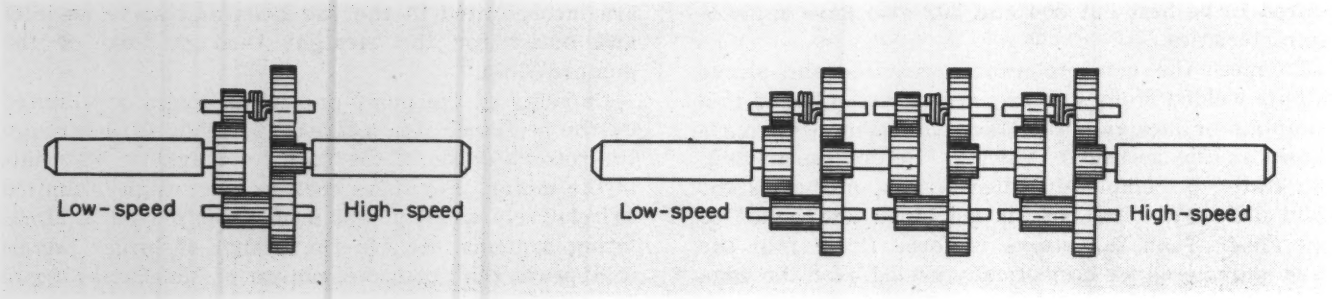
In combination with a 4-speed gearbox these ratios produce various shapes such as those illustrated below. The articulated system supporting the spindle bearings is sufficiently rigid and accurate so as to not give rise to errors resulting from deflection. To insure matching of internal and external profiles for mated parts, the spindles for external and internal grinding are mounted in the same bearings.

When grinding eccentrics, the machine will finish the piece on a single set of centers. The piece is first ground cylindrical. Then, after adjustment for the desired degree of eccentricity, the gyratory movement of the linkages will finish grind the piece to within 0.0008-inch tolerance.





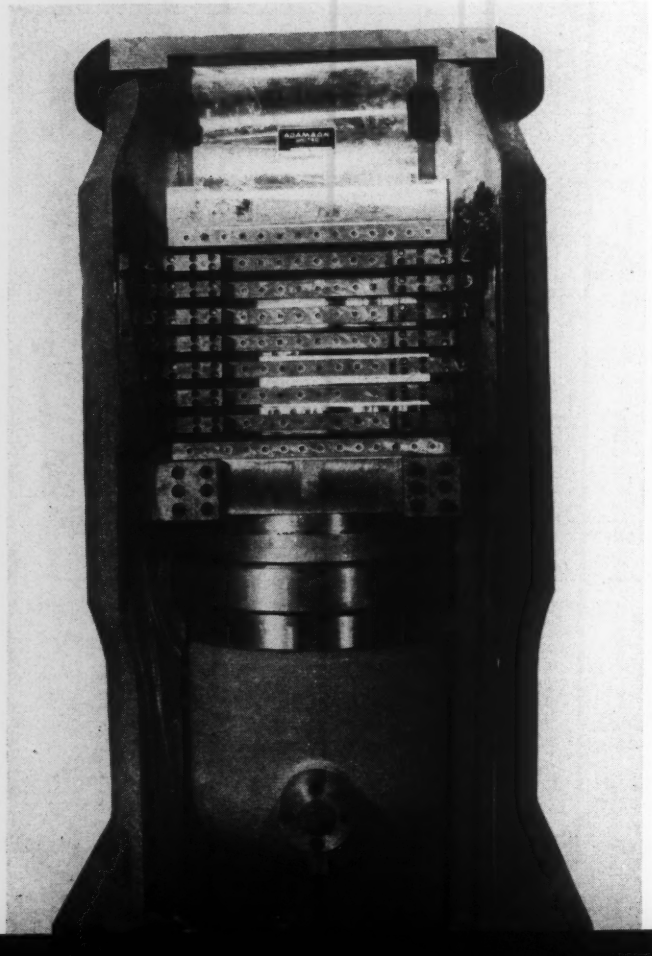




Antibacklash gearing, above, developed by Metron Instrument Co. for miniature speed changers utilizes two parallel reductions to form a locked train through a torsion spring between the gears on one countershaft. Tension in the spring just exceeds the maximum torque which the unit is expected to transmit. Play or backlash is taken up at each gear mesh since the torsion produced by the spring is reflected through all gear meshes in the closed loop. Spring deflection does not change except to compensate for inaccuracies in the train.

If the high-speed shaft is rotated in the clockwise direction, all useful output torque will be transmitted through the lower countershaft. The upper countershaft does not transmit useful torque but absorbs energy and lowers efficiency to the extent that the gears are operating under the load imposed by the spring. When the gearing is operated in the reverse direction, the output is transmitted through the spring and gears of the upper shaft. Transmission is positive up to the point of torque equal to the pretension on the spring. At that point the gears on the lower countershaft are not operating under load. Higher torque transmittal takes up the backlash in the opposite direction and the antibacklash feature does not function because of the lost motion in taking up the backlash.

In multiple sections of these double-reduction units, the springs in the higher speed sections are wound to a lesser degree corresponding to the torque transmitted through them. In applying this type of gearing, it is important to have ample input torque to overcome the losses and roughness inherent in preloaded gearing. The higher the ratio of the gearing the less noticeable is the input friction and roughness at the high-speed end because the torque of friction and roughness is geared down by simple mechanical advantage.

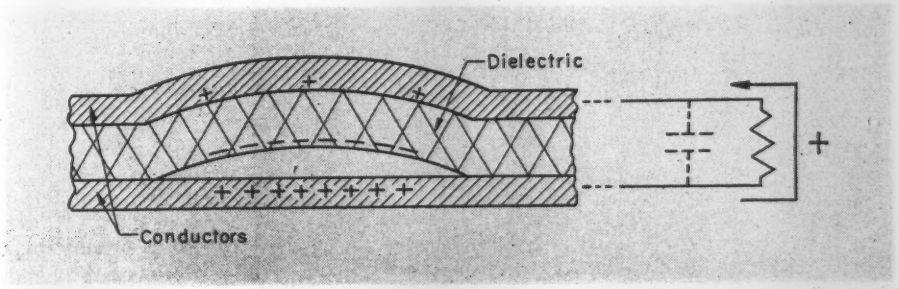


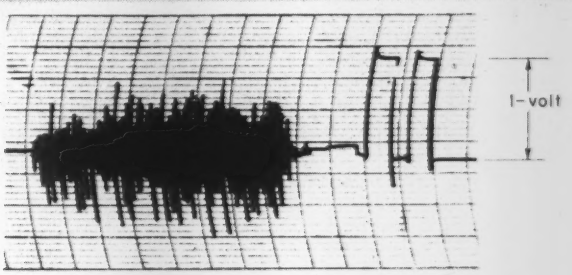
Circular side frames on the barrel press, left, provide increased rigidity at the high pressures required for plastic and synthetic rubber molding operations. The circular plates reduce the physical size of the press and a large sectional area ram provides the pressures required on the platens without employing special high-pressure hydraulic units.

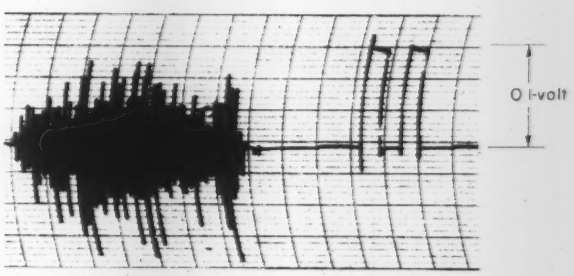
Conventional studs for holding the strain members or side plates to the cylinder and press head are replaced by top and bottom register plates. These plates are accurately machined to conform to the machined surfaces to which they are attached, eliminating the difficulty of loosened studs and resultant wear on the tongue-and-groove connection between strain plates and adjacent members. The curved side plates are cast steel and designed to guide the bolster and platens accurately. Intermediate platen hangers are easily arranged in the press and are mounted on the side frames as shown in the illustration.

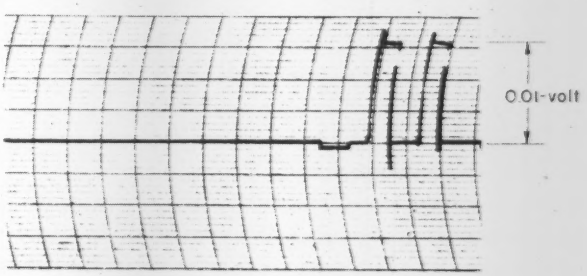
As the ram area approaches the area of the bolster, the problem of deflection is minimized and the capacity of the press is increased correspondingly without increasing line pressures. On a 24-inch platen press designed by Adamson United Co., the ram diameter is also 24 inches, resulting in a platen pressure approximately 76 per cent higher than that possible in conventional presses.

Ideas







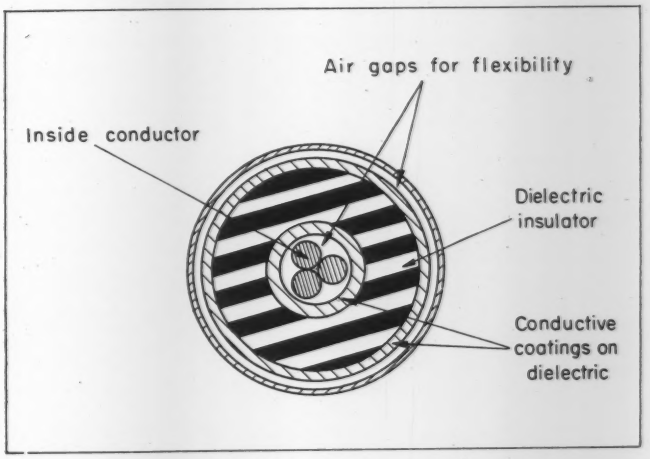


Noise-free instrument cables have long been desired for many types of instrumentation work where the cables are subjected to shock and vibration. These mechanical forces generate spurious electrical signals or "noise voltages" which interfere with measurements of pressure in underwater explosion or air-blast research and with determination of acceleration in shock and vibration studies. They also adversely affect the performance of crystal-type microphones, hearing aids, phonograph pickups, and many other high-impedence devices in the field of communication, measurement and control.

Shown at right are oscillograph traces of noise signals generated by severe whipping (first half of each trace) for three types of coaxial cable. The two square waves at the right of each recording are for calibration purposes. At the top is a trace for microphone cable having a diameter of 0.07-inch; in the middle is RG 62/U cable with a 0.24-inch diameter; and at the bottom is an experimental noise-free cable, 0.24-inch in diameter, developed experimentally for the Department of Defense and the Atomic Energy Commission by NBS.

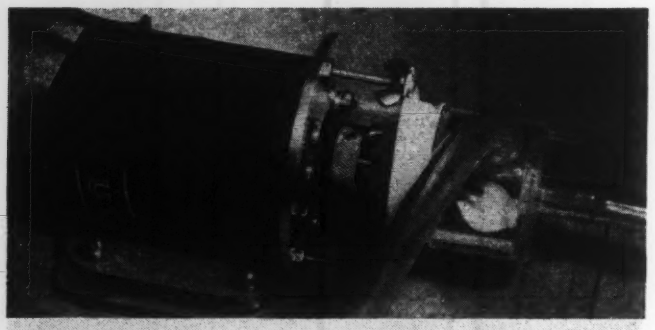
Schematic diagram above shows how noise current is believed to be produced in a coaxial cable by the relative motion of the conductors and the dielectric. When a temporary separation occurs between the dielectric and one of the conductors, a surface charge on the dielectric and an opposite charge on the conductor result. A portion of this charge ultimately appears on the other conductor opposite the separated charge on the dielectric. To free a cable from these unwanted signals, it is only necessary that the inside and outside surfaces of the dielectric be entirely covered by a well-bonded conductive coating.

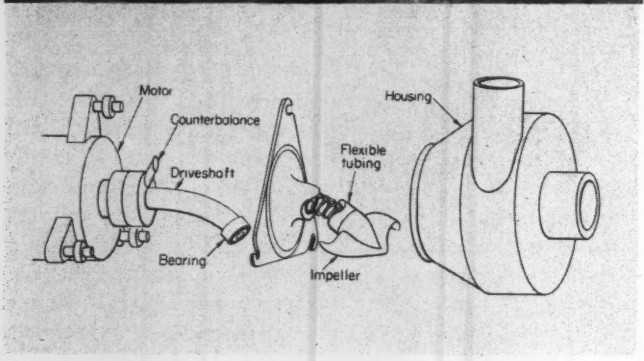
Structure of an experimental noise-free coaxial cable is shown at right. The insulating overall protective jacket is optional and does not require a conductive coating. This coating, employed only on the inside and outside surfaces of the dielectric, was made from a mixture of three parts by weight of finely divided (18 to 25 millimicrons) carbon black, ten parts of a flexible adhesive, and 60 parts of methyl ethyl ketone solvent. Until noise-free cable becomes available commercially, lengths up to six feet may be made from three different kinds of cable: Lamp cord having stranded-copper conductors between 0.006 and 0.007-inch in diameter is stripped of its insulation to make the inside conductor. "Push-back" hookup wire



with an AWG 20 conductor removed to form the dielectric is coated on the inside and outside with the conductive coating. Microphone or phonograph pickup cable about 0.070-inch having a readily removable shield is used for the outside conductor.

Ideas





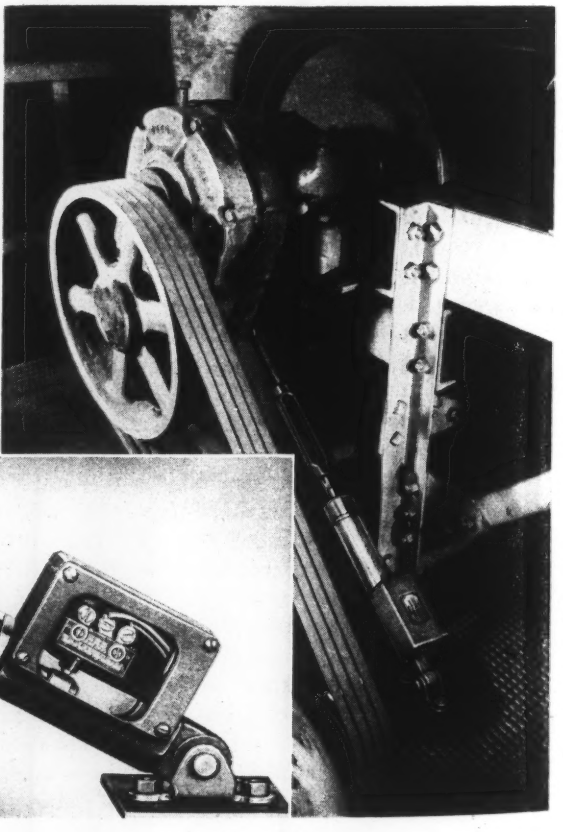
Hermetically sealed pump, shown above as a display model, has an orbital motion for its impeller instead of a conventional rotary motion. Vanes of the impeller are wave shape and remain in their horizontal plane, scooping the liquid from the pump center while pushing it to the housing perimeter. This action permits the pumping of liquids containing up to 20 per cent vapor without loss of efficiency and precludes the possibility of vapor lock. Also, because the pumping action does not depend upon a close fit between impeller and housing, liquids containing abrasives and relatively large solids may be pumped effectively.

Despite large clearances in the pump and the small size of the impeller, the pump is capable of developing useful pressures or vacuum. For example, a small water pump with a 1½-inch diameter housing develops a head of 35 feet of water when powered by a 1/25-horsepower motor at 4000 rpm. A 3-inch diameter pump powered by a 1/6-horsepower motor at 3600 rpm creates a suction of 27 inches of mercury.

A counterbalanced curved shaft coupled to the motor shaft drives the pump through flexible tubing as shown in the exploded view at left. On the end of this driveshaft is a ball bearing fitted into the impeller. Inasmuch as the rotary member is sealed from the pump chamber by the nonrotary flexible tubing no shaft seals are required. Invented by William Gemeinhardt at the Drexel Institute of Technology, the pump has been tested in a variety of applications in the chemical laboratories of the institute.

Overload protection for the foundry conveyor illustrated at right is simply and effectively provided by the release mechanism shown in cross section.

Protecting the 17.5-horsepower drive and equipment against damage resulting from overloads, the release mechanism may be adjusted to trip at any desired torque by varying the tension on its spring. Any load sufficient to displace the balls from their detent groove releases the mechanism quickly. Capable of tripping from either direction of loading depending on the method of application and direction of torque, the unit automatically resets itself when returned to position after tripping. On the end of the torque arm rod is a collar engaging a two-position precision switch. In the cocked position of the unit, the switch contacts are closed for the power control circuit. In the release position, these contacts open and another pair of contacts close to operate a signal. This overload release system was designed by the Dodge Manufacturing Corp.



Designing Leaf Springs

. . . for precision timing and indexing devices

By George V. Nolde
Consulting Engineer
Berkeley, Calif.

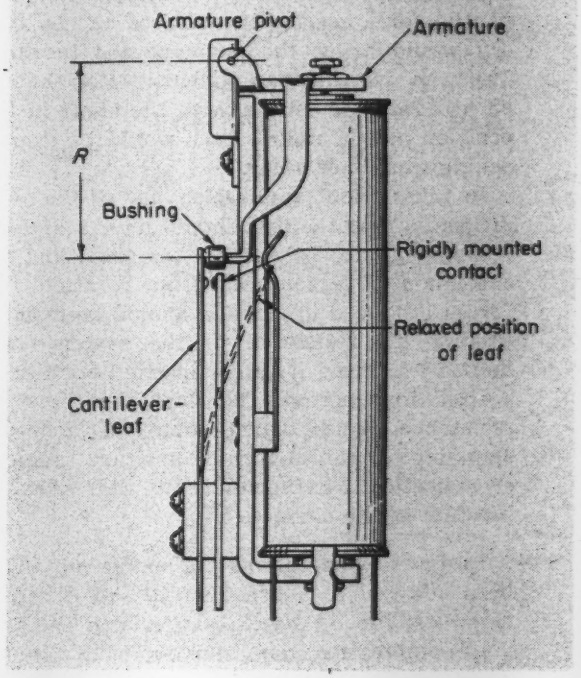


Fig. 1—Conventional electromagnetic relay utilizes elastic forces in predeflected cantilever leaf to close a switch contact. Distance R is the moment arm of resisting force F.

IN THE design of precision instruments and light machinery, flexible metal reeds or leaves are often utilized for various functions of actuating, indexing and timing. Functioning as thin flat springs restricted to move through a limited portion of their natural vibration cycle, these leaves have been successfully used as machine components in centralizers for indexing gears and shafts, actuators for escapements and latches, switch stacks in relays, contact blades in current interrupters, ratchet pawls, clutch actuators, and numerous other similar devices.

One of the most common applications of flexible leaves is the conventional electromagnetic relay shown in *Fig.* 1. The normally closed switch of this relay consists essentially of a cantilever leaf controlled in its movement by a bushing on the arm of the relay armature. With the electromagnet de-energized, the leaf must exert a force sufficient to maintain pressure against the rigidly mounted contact and hold the armature in a counterclockwise position relative to its pivot. This force is ordinarily obtained by predeflection of the leaf. If the rigid contact and the body of the magnet were removed, the leaf would assume the approximate position shown by the dotted line.

The relay could also have a normally energized biasing coil which would hold the armature in an attracted position, maintaining the leaf at its maximum deflection with an air gap between the tip of the leaf and the rigid contact. Then, upon receiving a signal, the control winding would release the armature and the leaf would move under its elastic forces through the air gap to a position against the contact. During this movement, elastic forces in the leaf would have to overcome its own inertia, inertia of the armature system and a resisting force on the bushing due to friction in the pivot and gravity pull on the armature.

Some of the design factors of the leaf such as its free length, material, extent of movement, and forces to be exerted in terminal positions would often be predetermined from kinematics of the device and collateral design considerations. Other design factors, such as configuration of cross-section and working deflections, would have to be computed to satisfy the dynamics of the system.

Another common application of flexible leaves is for

indexing shafts, *Fig.* 2. In the correct indexed position the leaf assumes the position shown, flat against one of the shaft faces. If the shaft rotation had ceased with the leaf resting against a corner, provided the "halfway" position had not been reached, a tangential force exerted by the leaf on the shaft periphery would bring the shaft to the indexed position. Thus, an overthrow or underdrive of the shaft would be avoided. Of course, with the shaft in the halfway position only a radial force would be exerted and indexing would not occur.

In this type of application, one of the essential conditions is that the leaf should have a kinetic response fast enough to "follow up" the shaft and also remain continuously in contact during rotation. Also static forces produced in the leaf should be capable of overcoming the resistance of the system—friction and inertia—to bring it to the indexed position within the desired time period. The leaf, while overcoming the resistance, would move from one deflection, corresponding to the "on-corner" position, to another smaller deflection corresponding to the indexed "on-flat" position of the octagon.

Design Considerations: Flexible metal leaves have been adapted to a great variety of different devices. However, for light-weight precision equipment, their main application has been as a "timing actuator". The devices shown in *Figs.* 1 and 2 fall within this category.

In order to generalize design analysis, a timing actuator of this type may be represented as a leaf having a variety of cross-sectional shapes and types of support with its forces and velocities referred to a single point on its surface. In this way a cantilever leaf may be considered as acting at its tip end only. If any special application would require a cantilever leaf to act through some intermediate point, it may be considered as a system composed of a short end-deflected cantilever leaf carrying an additional mass which has an inertia equivalent to the nondeflected end-portion of the actual leaf. Thus, for cantilever leaves, formulas for end-deflected leaves will suffice for all other cases. A typical end-deflected leaf with its nomenclature is shown in *Fig.* 3. An approach similar to the one used in dimensioning this type of elastic actuator would apply also to the leaves hinged at both ends, clamped at both ends, clamped at one end, hinged at the other, etc.

With the methods of computation presented in this article, kinetics of such leaves may be analyzed for different cross sectional configurations without regard to the dimensions of the individual leaves. This may be accomplished by considering a family of leaves having "optimum kinetics". In this family, the initial stress s_0 is constant. When certain limiting values in the dimensioning of an optimum leaf are utilized, that is, when prestressed to a fixed value s_0, obtained at initial deflection D_0, both a steel beam one mile long and a piece of watch spring one-half inch long, will move under their elastic forces through a given distance, η, between limiting positions at their free ends in exactly the same time interval.

A treatment of this sort facilitates proper selection of the main factors in design. When an evaluation of other than the basic modes of motion presented here are of interest to the designer, more laborious and rigorous methods of computations are preferred.[1, 2, 3] Calculations of an optimum leaf, however, may be ad-

Nomenclature

D = Deflection of leaf end, inches
D_0 = Maximum deflection, actuated or latched position, inches
E = Modulus of elasticity of leaf material, psi
F = Elastic force exerted by leaf end at deflection D, lb
F_0 = Elastic force exerted by leaf end at deflection D_0, lb
F_r = Resisting force, lb
K = Proportionality constants
M = Mass of attached component, lb-sec^2 per inch
P_D = Potential energy of leaf at deflection D, in.-lb
P_0 = Potential energy of leaf at deflection D_0, in.-lb
P_r = Work of force, F_r, over distance η, in.-lb
a = Thickness of leaf, inches
b = Width of elastic prismatic leaf, inches
b_n = Width, at support, of nonprismatic leaf, inches
l = Length of leaf, inches
f = Elastic force per linear unit of leaf width at supported end for deflection D, lb per inch
f_0 = Elastic force per linear unit of leaf width at supported end for deflection D_0, lb per inch
n = Ratio, D_0/η
s = Leaf stress at deflection D, psi
s_0 = Leaf stress at deflection D_0, psi
t_1 = Time interval for leaf end travel through distance η, sec
x = Abscissa of leaf
y = Ordinate of leaf
ϕ = Functional notation (Equation 16)
ψ = Functional notation (Equation 17)
η = Total end travel of leaf, $D_0 - D$, inches
ρ = Density of leaf material, lb-sec^2 per inch per inch^3

Table 1—Constants for Flat Cantilever Leaves*

Constant	Prismatic Shape	Triangular Shape
K_4	1.42	0.48
K_5	13.5	6.0
K_6	0.67	1.00
K_7	0.39	0.19
K_9	0.23	0.04
K_{15}	2.08	0.24

* For any other leaf shape, compute from general procedure in Appendix.

[1] References are tabulated at end of article.

vantageously utilized in the studies of higher harmonics as a guide for extended research.

Flat Cantilever Leaves: Factors, defined in the nomenclature, determining the performance of flat cantilever leaves are:

1. Material factors: E, ρ, s_0
2. Terminal conditions: F_0, f_0, D_0, D
3. Stroke and work resistance: η, M, F_r
4. Timing: n, t_1
5. Dimensions of the leaf: a, b, l

Some of these factors will be furnished by predetermined design considerations; others must be computed to conform to the predetermined set. Transposition of the various equations and expressions will be determined by the most appropriate method of handling a given set of initial data.

To facilitate understanding of a general design procedure, the following discussion presents equations which have been compiled for conditions often encountered in design. A listing of constants for use in these equations is presented in TABLE 1. General procedures for the derivation of these formulas and constants for any type of support or shape are presented in an appendix at the end of this article.

Of basic interest for flat leaves is the equation:

$$t_1 = K_4 n \eta \left[\cos^{-1} \left(1 - \frac{1}{n} \right) \right] \sqrt{\frac{\rho E}{s_0^2}} \quad \ldots\ldots (1)$$

This equation furnishes the limiting values for kinetic response of materials. By using this equation, maximum speeds with which the tips of flat cantilever actuators, regardless of their proportions, will move under their elastic forces through an air gap may be evaluated. The graph of Equation 1 for prismatic leaves of steel, phosphor bronze, and spring brass, prestressed to safe values of s_0 near their elastic limit, is shown in *Fig.* 4.

When a mass M is attached to the end of a cantilever leaf and a resisting force F_r is present, the time t_1 should be multiplied by coefficient K_{11} to give

$$t_1 = K_{11} K_4 n \eta \left[\cos^{-1} \left(1 - \frac{1}{n} \right) \right] \sqrt{\frac{\rho E}{s_0^2}} \quad \ldots\ldots (2)$$

For certain combinations of initial factors the value of K_{11} may be conveniently computed from

$$K_{11} = \sqrt{\frac{K_1}{1 - K_2}} \quad \ldots\ldots (3)$$

where

$$K_1 = \frac{M}{K_9 \rho\, abl} + 1 \quad \ldots\ldots (4)$$

and

$$K_2 = \frac{F_r}{F_0} \quad \ldots\ldots (5)$$

Another solution for K_{11} which may be more desirable under some conditions is

$$K_{11} = \sqrt{\frac{F_0}{F_0 - F_r} \left(\frac{M s_0^2}{K_{15} \rho\, E F_0 \eta\, n} + 1 \right)} \quad \ldots\ldots (6)$$

In this equation, the influence of mass and resistance at the tip of the leaf are expressed without in-

Fig. 2—Triangular cantilever leaf used as a timing actuator indexes shaft at high speeds and maintains constant contact with the periphery. Width of leaf, b_n controls the amount of energy exchanged betwen leaf and shaft

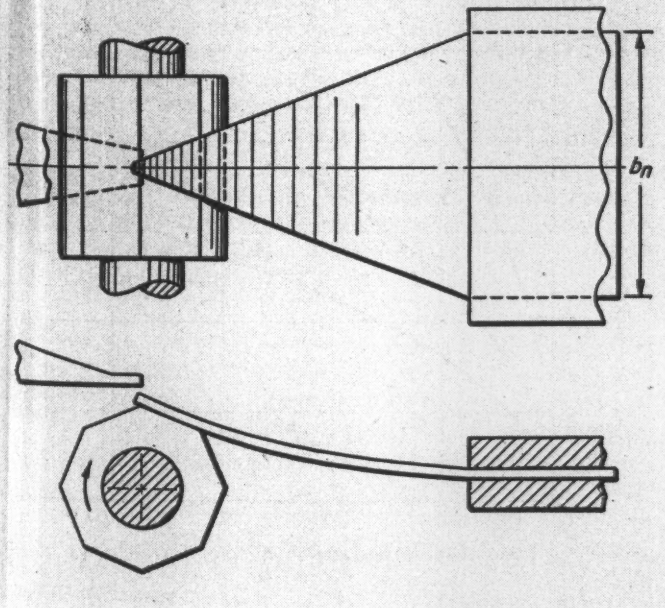
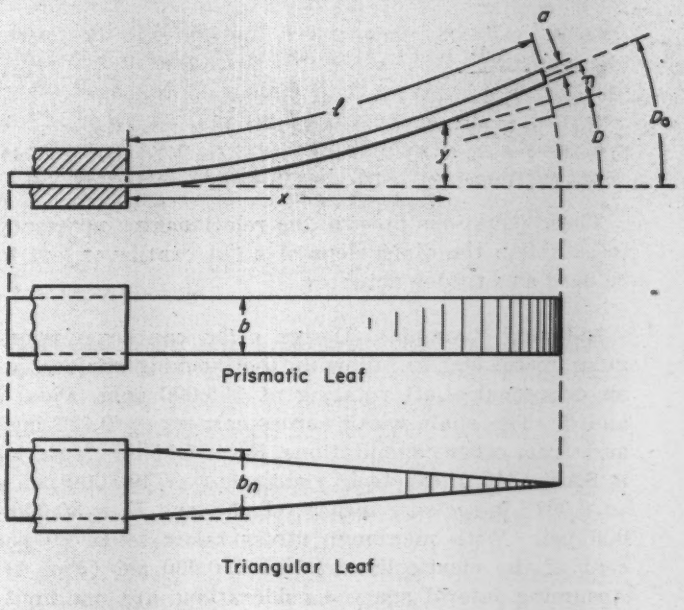


Fig. 3—Difference in shape of triangular and prismatic leaves affects the time, t_1, required for the leaf end to travel from deflection D_0 to deflection D. Kinetic response of triangular leaf is 3 times that of the prismatic shape



cluding dimensions of the leaf.

Combining Equations 2 and 6 gives

$$t_1 = K_4 \eta n \left[\cos^{-1} \left(1 - \frac{1}{n} \right) \right] \times \sqrt{\frac{F_0}{F_0 - F_r} \left(\frac{M}{K_{15} F_0 \eta n} + \frac{\rho E}{s_0^2} \right)} \quad \ldots\ldots (7)$$

which is comparable to Equation 1.

Under any conditons, K_2 must not exceed $1-(1/n)$. Otherwise the elastic force F available at the terminal deflection D would not be great enough to overcome force F_r.

It is important to note that Equations 1, 2, and 7 contain no dimensions of the leaves; they present the timing factors with respect to an optimum leaf. The following expression, however, is useful in relating travel time t_1, with a kinematically and dynamically outlined leaf.

$$t_1 = K_{11} K_7 \sqrt{\frac{\rho s_0 l^3}{E f_0}} \left[\cos^{-1} \left(1 - \sqrt{\frac{K_5 \eta^2 E^2 f_0}{s_0^3 l^3}} \right) \right] \quad \ldots\ldots (8)$$

Among other observations, from Equation 8 it follows that for a free leaf with the given material factors, the time t_1 will not change with the length l, provided the width of the leaf (or the terminal force F_0) is altered to keep constant the ratio $l^3/f_0 = l^3 b/F_0$. For leaves weighted and damped at their ends the product $l^3 b$ determines the constancy of t_1, while F_0 should take into account the composition of K_{11} in Equation 6.

To complete the computation of design data, the following equations define other necessary variables:

$$n\eta = D_0 \quad \ldots\ldots (9)$$

$$D = \eta (n - 1) \quad \ldots\ldots (10)$$

$$n = \sqrt{\frac{s_0^2 l^3}{\eta^2 E^2 f_0 K_5}} \quad \ldots\ldots (11)$$

$$l = \frac{1}{s_0} \sqrt[3]{K_5 E^2 D_0^2 f_0} \quad \ldots\ldots (12)$$

$$a = \frac{K_6 s_0 l^2}{E D_0} \quad \ldots\ldots (13)$$

$$b = \frac{F_0}{f_0} \quad \ldots\ldots (14)$$

These equations provide the relationships necessary to establish the dimensions of a flat cantilever leaf to be used as a timing actuator.

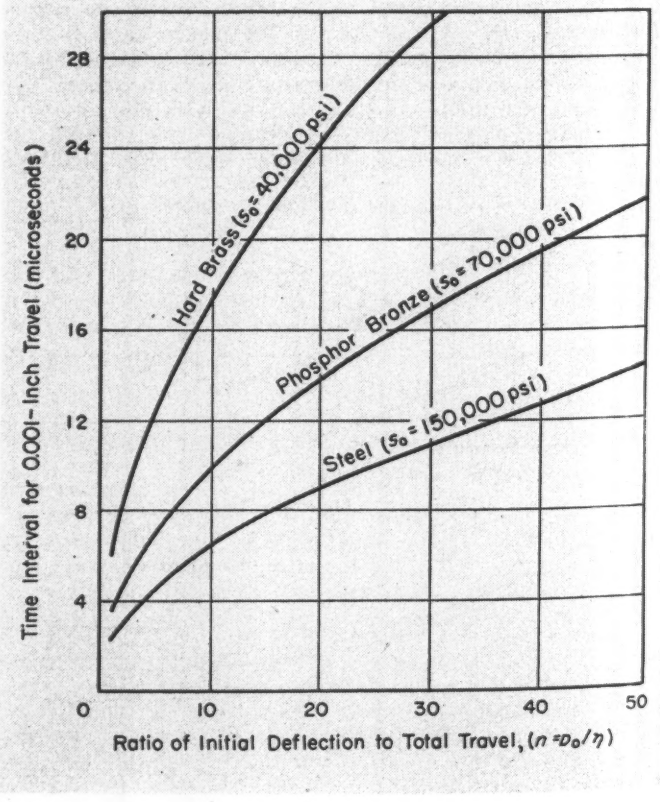
Indexing Example: Design a flat cantilever triangular metal leaf to follow-up the indexing surfaces of an octagonal shaft rotating at 175,000 rpm, *Figs.* 2 and 3. The shaft width across corners = 0.125 inch and, from other computations, F_0 = 0.15 lb. Material is SAE 4340 alloy steel; yield point = 190,000 psi, ρ = 0.0073 lb-sec^2 per inch per inch^3, and E = 30,000,000 psi. With maximum stress taken to be 80 per cent of the elastic limit, s_0 = 150,000 psi (*Fig.* 4). Assuming lateral space considerations are not limiting, a convenient force distribution is f_0 = 0.5 lb per inch.

The leaf must move from "on-corner" position to "on-flat" while the shaft rotates 1/16 revolution or 22.5 degrees. This time interval at 175,000 rpm is t_1 = 21.43 microseconds. The travel distance from on-corner to on-flat positions for the indexing leaf is η = 0.0625 (1 − cos 22.5) = 0.0048 in. In view of rather extreme requirements for the fast follow up, a triangular leaf is selected because, according to TABLE 1, the coefficient K_4 for triangular leaves is only 1/3 of that for prismatic leaves.

Reviewing the status of the computation thus far, the following initial factors are known: F_0, ρ, E, s_0, f_0, t_1, η. Additionally, available from TABLE 1 for triangular leaves are values for K_4, K_5, K_6, K_7, K_9, K_{15}. The factors F_r and M are both implied to be zero in this computation for the follow-up movement. However, in the second phase of action of the leaf, when it performs the actual indexing motion, both of these factors re-enter the problem, but the computation method is then different. Unknowns to be determined are: l, a, b_n, n, D_0, and D.

A value for n should be determined first by solving Equation 1. This may be easily accomplished using the graphical solution presented in *Fig.* 4. It must be remembered that the curves in *Fig.* 4 are

Fig. 4—Graphic solution of Equation 1 facilitates determination of t_1 or n. Curves are for prismatic leaves only and correction factors must be employed for triangular leaf determinations



based on prismatic shapes and a travel distance of 0.001 inch. Thus, to use these curves for solution of n in this problem requires that certain conversions of initial values be made. Since $t_1 = 21.43$ microseconds for a travel distance of 0.0048 inches, the time for a travel of 0.001 inch will be 4.46 microseconds. Also, from a comparison of the values of the constant K_4 (TABLE 1) for flat leaves and prismatic leaves, a correction factor of $1.42/0.48 = 2.96$ is obtained. This correction factor is indicative of the slower response of prismatic shapes. The ordinate for entering the steel curve, therefore is $4.46(2.96) = 13.2$ microseconds from which $n = 43$.

From Equation 9, $D_0 = 43(0.0048) = 0.206$ inch.
From Equation 10, $D = 0.0048(42) = 0.201$ inch.
From Equation 12, $l = (1/150{,}000)\,[6(900)(10^{12})(0.0426)(0.5)]^{1/3} = 0.324$ inch.
From Equation 13, $a = 150{,}000(0.105)/30{,}000{,}000(0.206) = 0.00255$ inch.
From Equation 14, $b_n = 0.15/0.5 = 0.3$ inch.

Any readjustment of computed values should be based on the relationships presented in Equation 8. For example, if kinematic considerations call for a longer leaf so that $l = 2(0.324) = 0.648$ inch, adjustments in the values of b_n, f_0, and a must be made to retain optimum leaf characteristics. To maintain the product $l^3 b_n$ constant and thus retain the same t_1, $b_n = 0.3/2^3 = 0.0375$ inch and from Equation 14, $f_0 = 0.15/0.0375 = 4.0$ lb. Also from Equation 13, the new value of a is 0.0102 inch. All other factors remain the same and optimum-leaf requirements will thus have been met.

The leaf, *Fig.* 3, dimensioned in accordance with these computations will maintain contact with the octagonal shaft up to approximately 175,000 rpm and will be in a position to index the shaft whenever it stops. Accuracy of these computations is within 3 to 5 per cent; however, other engineering assumptions also should be kept in view. For example, the leaf in this case will not act exactly at its tip, but at a small distance from it; the density of metal ρ and Young's modulus E have tolerance ranges, etc.

Discussion of computation of the leaf, *Fig.* 3, with respect to indexing forces would involve too much material extraneous to the present subject.[4] It may be pointed out, however, that analysis of indexing action would require calculation of the leaf force versus inertia and friction determined by separate procedures. Therefore, to exemplify the computation for a damped actuator, it would be better to consider the design task for determining the dynamics of the relay shown in *Fig.* 1.

Damped Actuator Example: For the design of this type of timing actuator, material characteristics, terminal forces, and the air gap distance η are selected from the initial analysis. Kinematics of the armature and space requirements predetermine l and b. Equivalent mass $M = I_a/R^2 =$ where $I_a =$ the total inertial moment of the armature system, and $R =$ the distance from the armature pivot to the bushing. Also, the resisting force would be produced by the armature gravity moment, I_g, and friction moment, I_f, giving $F_r = (I_g + I_f)/R$.

For example, design a switch leaf for the electromagnetic relay in *Fig.* 4. Phosphor bronze is the material and $\eta = 0.010$ inch, $b = 0.1$ inch, $l = 1$ inch, $M = 3\text{x}10^{-5}$ lb-second^2 per inch, and $F_r = 0.025$ lb. Select $s_0 = 70{,}000$ psi. Also, a practical value for F_0 is 0.08 lb. The calculation will be for a leaf of prismatic shape.

From Equation 14, $f_0 = 0.08/0.1 = 0.8$ lb.
From Equation 11, $n = [(70{,}000)^3/(0.010)^2(14 \times 10^6)^2\ (0.8)(13.5)]^{1/2} = 40.2$ inches.
By calculation, $F_r/F_0 < [1 - (1/n)]$, thus satisfying the requirement for this condition.
From Equation 9, $D_0 = 40.2(0.01) = 0.402$ inch.
From Equation 10, $D = 0.392$ inch.
From Equation 13, $a = (0.67)(7 \times 10^4)/(14 \times 10^6)(0.402) = 0.0083$ inch.
From Equation 6,

$$K_{11} = \sqrt{1.45\left[\frac{(3 \times 10^{-5})(7 \times 10^4)^2}{(2.08)(11{,}494)(8 \times 10^{-2})(0.402)} + 1\right]} = 16.7$$

A value for t_1 may be found from Equation 7, or the curve in *Fig.* 4 may be used. For $n = 40.2$, the corresponding time ordinate is 19.2 microseconds. Multiplying by correction factors of 10 for η and 16.7 for K_{11} and converting to milliseconds gives $t_1 = 19.2(16.7)(10)/1000 = 3.2$ milliseconds. This is a minimum operating time for a relay using this leaf.

It is interesting to observe, that if this relay is placed horizontally, to bring F_r near to zero, the value 1.45 found from Equation 6 approaches unity and the operating time t_1 will be about 2.7 milliseconds. In ordinary design practice, however, without reliance on the limit properties in the dynamics of metals, the thickness a would be chosen to be of the order of 0.016 inch with smaller D_0 and s_0 to obtain the desired F_0. The response time of the leaf will then increase, but this is offset by the decreases in the inertial component K_1 so that the operating time t_1 remains nearly the same as before, about 2.75 milliseconds.

Most of the present relay constructions do not utilize the possibilities hidden in the phenomena of kinetic response of metals and appreciable advances may be made in this art by inventions using full implications of the theory discussed in this article.

For complete flexibility in the treatment of the range of design problems, a convenient method for derivations of all desired formulas of the type exemplified for cantilever leaves is presented in the following Appendix.

Appendix: Certain approximations in the study of basic modes of motion of flexible timing actuators, such as those discussed, permit a saving in effort with but a small inaccuracy in performance prediction. One of the procedures for the derivation of these equations employs the Rayleigh method[5] and consists of a mutual solution of the following Equations 15, 16, 17, 18, 19 and 20.

A more-or-less conventional manner for expressing t_1 without correlating it to initially expected forces is

$$t_1 = -\int_{D_0}^{D}\left[K_{11}\sqrt{\frac{Z}{2(P_0 - P_D)}}\right] dD \quad \ldots\ldots (15)$$

where

$$Z = \int_0^l \frac{y^2 \rho a b}{D^2}\, dx$$

Also, y and $P_0 - P_D$ are functions resembling elastic curve and potential energies, respectively, of the deflected leaf of a given form.[6,7] The values a and b are, of course, the functions of x corresponding to the leaf shape.

The correlation used in equations similar to Equation 1, however, is based on Equation 15 solved together with the equations for the elastic forces taken from the theory of elasticity and having the functional forms

$$F = \phi\ (s, b_0, a_0, l) \quad \ldots\ldots (16)$$

and

$$D = \psi\ (F, E, b_0, a_0, l) \quad \ldots\ldots (17)$$

where a_o and b_o are thickness and width at the points of maximum stress. For example, as applied to flat leaves, these equations become

$$F = \frac{K_{12} b_0 a_0^2 s}{l}$$

and

$$D = \frac{K_{13} F l^3}{E b_0 a_0^3}$$

where K_{12} and K_{13} account for the shape of the leaves.

From the definitions of the variables given in the nomenclature:

$$n = \frac{D_0}{\eta} \quad \ldots\ldots (18)$$

$$\eta = D_0 - D \quad \ldots\ldots (19)$$

$$f_0 = \frac{F_0}{b_n} \quad \ldots\ldots (20)$$

From this analysis (Equations 15, 16, 17, 18, 19, and 20) it can be seen that six resultant design variables can be determined. A careful appraisal of these equations will indicate which variables can be mutually determined by less than six equations. To avoid incompatible relations, such variables, of course, should not be entered into a set of independently selected variables without preliminary exclusion.

Use of the constant K_{11}, which in free moving and nonweighted leaves is unity, is determined by a separate set of equations of which Equation 4 is the direct result of the basic Rayleigh energy equation. However, Equations 3 and 6 are derived by simultaneous application of Rayleigh's relations and the additional considerations that in any linear elastic system ($F = K_3 D$), for comparatively large n, the work done by the elastic forces F over the distance η minus the work over the same distance by the resisting force F_r may be approximated as

$$(P_0 - P_D) - P_r \approx (1 - K_2)(P_0 - P_D) \quad \ldots\ldots (21)$$

The accuracy of Approximation 21 depends on the accuracy of the approximation

$$F_r = K_2 F_0 \approx K_2 F \quad \ldots\ldots (22)$$

Also, with Approximation 22 assumed the following approximations are offered;

$$P_0 - P_D \approx \int_D^{D_0} K_3 D dD = \frac{K_3 (D_0^2 - D^2)}{2} \quad \ldots\ldots (23)$$

$$P_r \approx \int_D^{D_0} K_2 F\, dD = K_2 \left(\frac{K_3}{2}\right) \times$$

$$(D_0^2 - D^2) \approx K_2 (P_0 - P_D) \quad \ldots\ldots (24)$$

Approximation 21 follows directly from Approximations 23 and 24.

A comparison of Approximation 21 with the value of $(P_0 - P_D) - P_r$ obtained without the use of Approximation 22 indicates the inaccuracy in the final result introduced by resorting to Approximation 22. To bring the precision of computations utilized in Approximation 22 to the same order as the rest of the formulas, K_{11} should be multiplied by the correction coefficient K_{14}.

$$K_{14} = \frac{\cos^{-1}\left[1 - \dfrac{1}{n(1 - K_2)}\right]}{\left[\cos^{-1}\left(1 - \dfrac{1}{n}\right)\right]\sqrt{\dfrac{1}{1 - K_2}}}$$

Usually, K_{14} may be disregarded.

In applying this general procedure it must be remembered that the Rayleigh method is only one of the elements in the general method. For example, instead of the derivation of t_1 by Equation 15, which is based on Rayleigh, any other available technique for determination can be substituted. Then, the consequent application of Equations 16 through 20, Approximation 21, and Equation 3 would bring the same array of expressions as realized here. Any differences will lie only in the accuracy of the numerical constants calculated. For most practical design problems, however, the general procedure as discussed would yield sufficiently accurate results without further refinement.

REFERENCES

1. R. D. Mindlin—"Response of Damped Elastic Systems to Pulse Accelerations," *Proceedings of 6th International Congress of Applied Mechanics*, Paris, France, 1946.
2. W. H. Hoppman—"Impact of a Mass on Damped Elastically Supported Beam," *Trans. ASME*, Vol. 70, 1949, Page 125.
3. C. A. Nothmann—"Vibration of a Cantilever Beam with Prescribed End Motion," *Trans. ASME*, Vol. 70, 1948, Page 327.
4. W. E. Mathi and C. K. Studley—"Developing a Counting Mechanism," MACHINE DESIGN, June 1950, Page 117.
5. Lord Rayleigh—*Theory of Sound*, London, 1877, Vol. 1.
6. S. Timoshenko—*Vibration Problems in Engineering*, Van Nostrand Co., New York, 1937, Chap. 2, Art. 22.
7. J. P. Den Hartog—*Mechanical Vibrations*, McGraw-Hill Book Co. Inc., New York, 1947, Chap. 8, Art. 71.

"When a fighter pilot rushes into action at 600 miles an hour against another fighter coming at him likewise at 600 miles an hour—a total speed of 1200 miles an hour—electronics must find the target, direct the gun, and pull the trigger. The cost of electronics alone in some of the new jet bombers is more than the total cost of two B-29s."—C. E. WILSON, *president, General Electric Co.*

Basic Design of Hydraulic Flow Regulators

By H. G. Conway
Technical Director
British Messier Ltd.
Gloucester, England

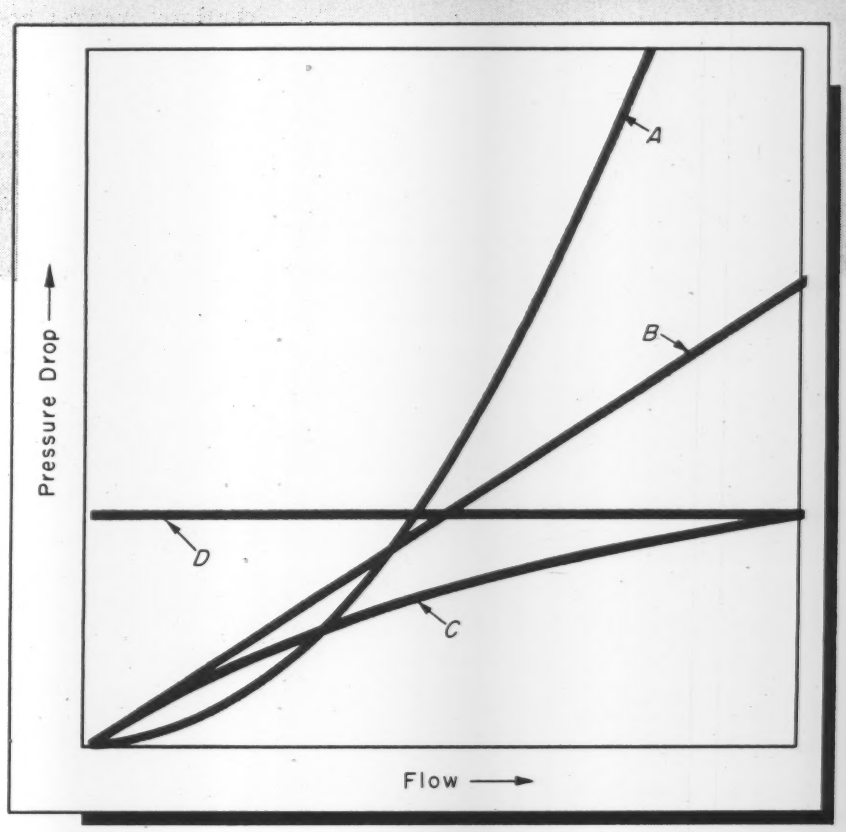


Fig. 1—Characteristic flow curves for various restrictors, showing turbulent flow at *A*, laminar or viscous flow at *B*, "sublaminar" flow at *C*, and flow equivalent to mechanical friction at *D*

IN MANY hydraulic systems oil flow must be regulated in all or part of the system, usually to control the speed of operation of a hydraulic motor or cylinder, or to synchronize the relative rates of operation of several units. Such control of flow may be achieved with simple restrictors, flow regulators or throttles, flow-control valves, or flow synchronizers or dividers. These flow regulation devices all have a certain family similarity which is easier to understand if their principles are considered together. It is apparent, judging by the variety of valves which have been designed or patented in recent years, that many inventors have not always appreciated the principles involved.

Restrictors: A restrictor or throttle is too well-known to require much discussion. Although restrictors involving laminar or viscous flow (curve *B* in *Fig.* 1) are used, the normal type for speed regulation consists of a plain orifice, the flow being turbulent (*A* in *Fig.* 1).

Common types of laminar flow restrictors are illustrated in *Fig.* 2. An example of the long-orifice restrictor is the coil of several feet of small-bore pipe used to damp pressure fluctuations to a pressure gage. A spring-controlled type is used in automobile shock absorbers in various forms. The required characteristics are obtained by using a lift valve with no

initial spring tension, the valve lifting progressively as flow increases. A "sublaminar" characteristic curve (*C* in *Fig.* 1) is often specified by shock absorber designers and can be obtained by suitable proportioning of the valve. It may be noted in passing that if the valve spring were fitted with initial tension the flow curve could be like *D* in *Fig.* 1—equivalent to mechanical friction.

A restrictor is rarely used for accurate speed regulation in a hydraulic system because it is very sensitive to variations of pressure (or the work load) and, to a lesser degree, to temperature and viscosity effects. True turbulent flow, usually assumed when dealing with orifices, is sensitive to fluid density and therefore to temperature, but not to fluid viscosity. In practice, however, flow is rarely fully turbulent, so viscosity changes due to temperature will also affect flow in the restrictor.

There are many other variables which add to the difficulty of an analytical study of orifices except under the simplest of physical conditions. If, however, flow is assumed to be fully turbulent, incoming velocity to the orifice is neglected (hydrostatic conditions) and variations in fluid density due to temperature changes are ignored, the flow through an orifice is given by the equation:

$$Q^2 = 1.45 \times 10^4 \, C^2 p_d D^4$$

where Q = flow, cu in. per sec; C = orifice coefficient; p_d = pressure drop, psi; D = orifice diameter, inches. In this equation, specific gravity of the oil is considered to be 0.9, an average value for light hydraulic oil.

Variation of flow with changes in pressure and orifice diameter from this equation are shown graphically in *Fig.* 3. The orifice coefficient, generally 0.65 to 0.75 for normal drilled-hole orifices but higher with "streamline" shapes, is here taken as 0.75.

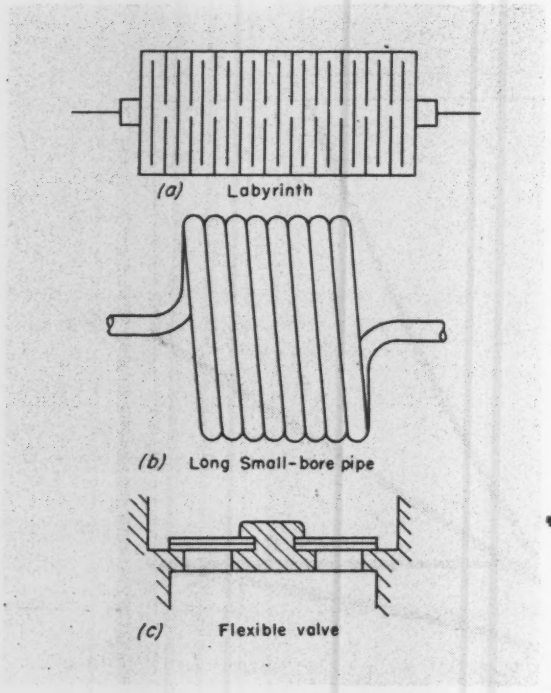
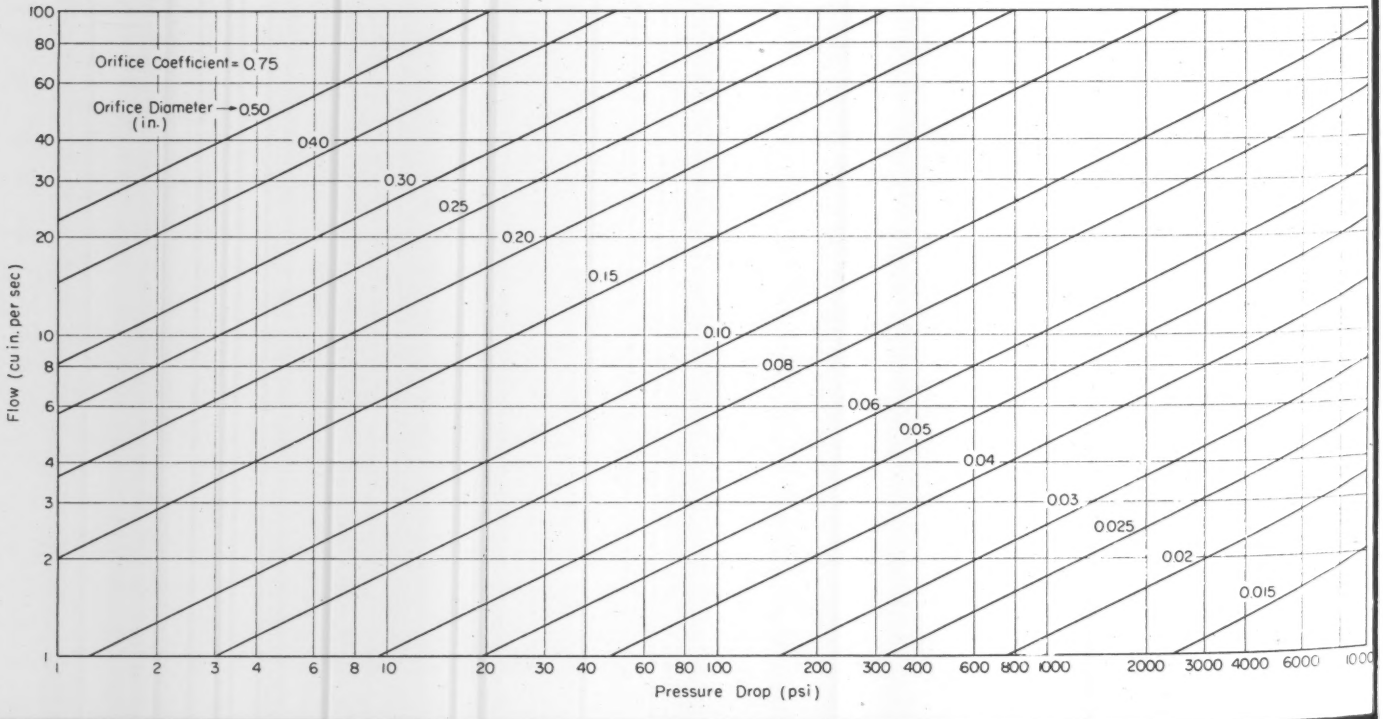


Fig. 2 — Left — Common restrictors for controlling laminar flow

Fig. 3—Below—Flow vs pressure drop curve for turbulent flow through drilled-hole orifices of different diameters



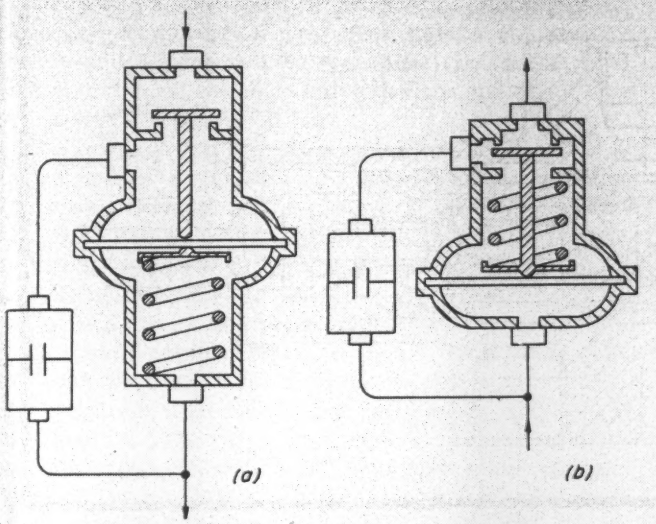


Fig. 4—Flow regulators or throttles, showing how a diaphragm and variable-inlet orifice can be introduced before, *a*, or after, *b*, the fixed orifice to maintain a constant pressure drop across it

Flow Regulators: A flow regulator or throttle can be considered as a two-connection valve inserted in a hydraulic line to regulate the flow (from a variable delivery pump or accumulator). Valves of the three-connection type which divide part of the flow are here called flow-control valves and are described later.

It is quickly apparent from *Fig.* 3 that the only means of maintaining a constant flow across a simple restrictor is to maintain a constant pressure difference across it, in which case flow constancy will be automatic.

This pressure difference is held constant by introducing a second and variable restrictor in series with the fixed orifice, either before or after it. *Fig.* 4*a* shows diagrammatically how this can be accomplished with a reducing valve. The diaphragm of this valve is subjected to the differential pressure across the fixed orifice, and the inlet valve is thus automatically adjusted to maintain a constant differential pressure. The same system, with the fixed orifice before the valve is shown in *Fig.* 4*b*, the action merely being reversed.

In practice, valves are usually designed to make use of a slide rather than the diaphragm. *Fig.* 5*a* illustrates the elementary mechanism of a typical valve of the type shown in *Fig.* 4*a*. *Fig.* 5*b* on the other hand, shows a valve in which the reducing valve mechanism is on the second orifice, as for *Fig.* 4*b*, the first or inlet orifice being contained inside the piston for convenience. For free, unthrottled return flow, the orifice may conveniently be drilled in a check valve, *Fig.* 5*c*.

High accuracy of flow regulation is not usually required in the average hydraulic system, and careful design can give a satisfactory control level over a wide range of pressure differences. Since the pressure setting of a reducing valve is affected by fric-

Fig. 5—More common basic designs for the flow regulators in *Fig.* 4. A method of allowing free return flow is shown at *C*

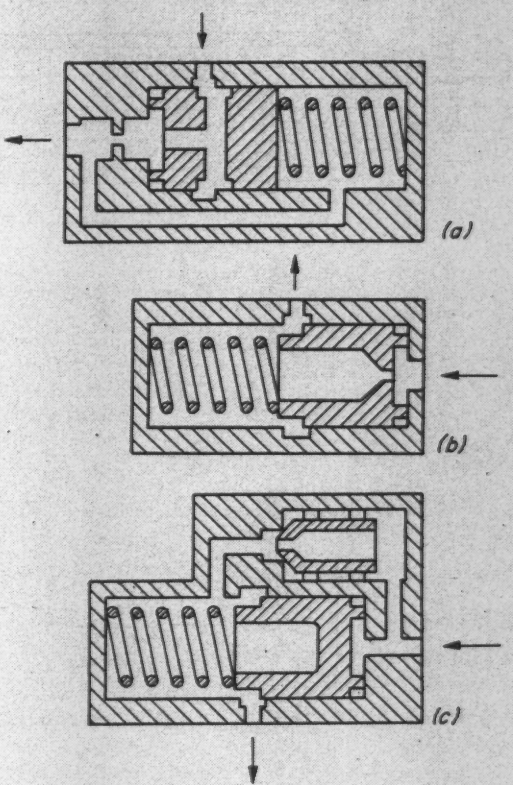
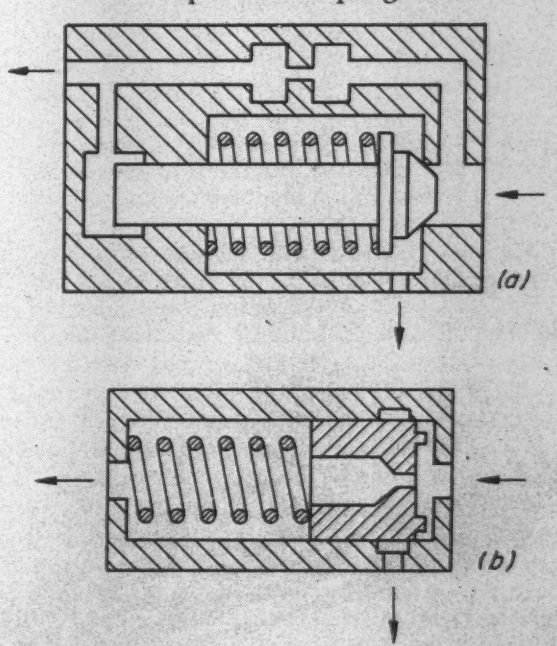


Fig. 6—Flow-control valves, in which excess input is by-passed. Pressure drop across the fixed orifice is equal to the spring force



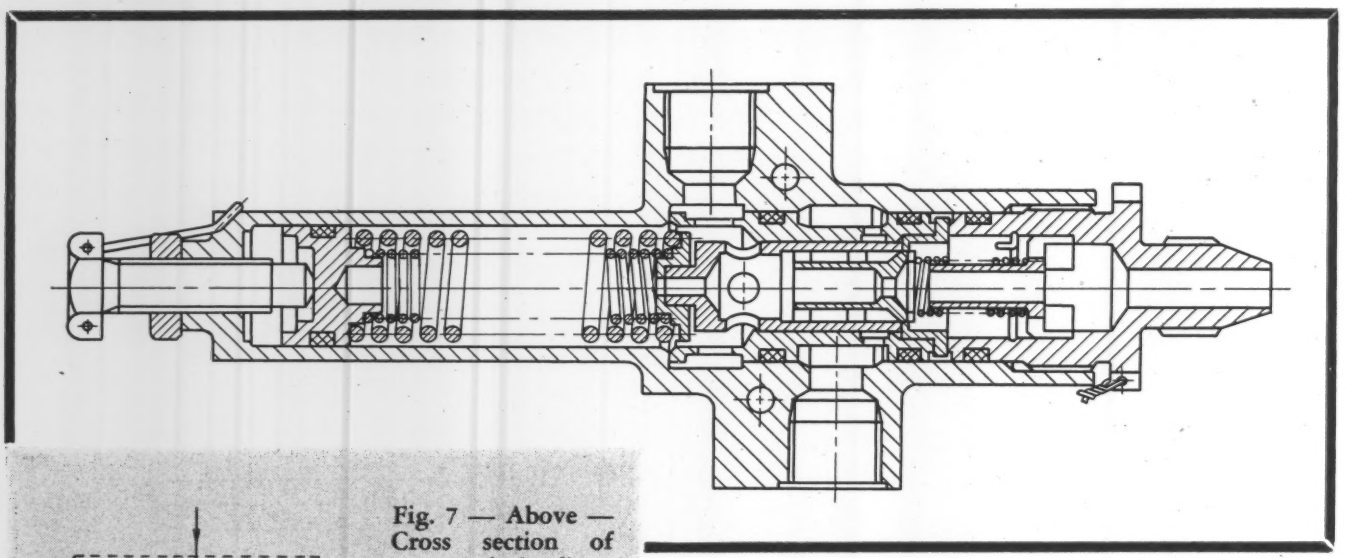


Fig. 7 — Above — Cross section of a practical flow-control valve

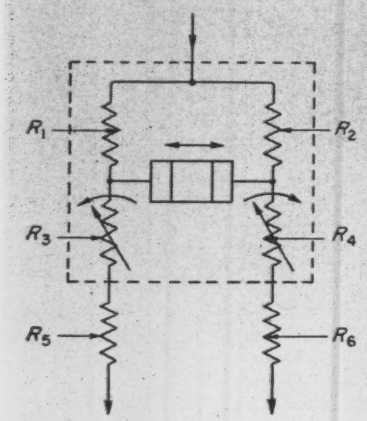


Fig. 8— Left—Analogy for a flow divider. Sum of the resistances in each branch must be equal for equal flow

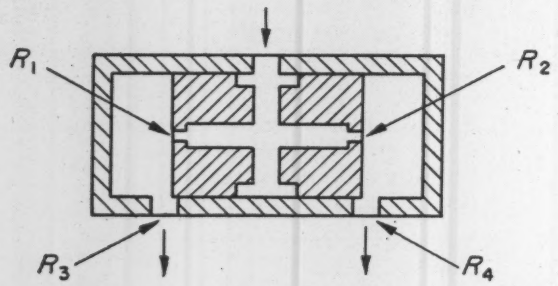
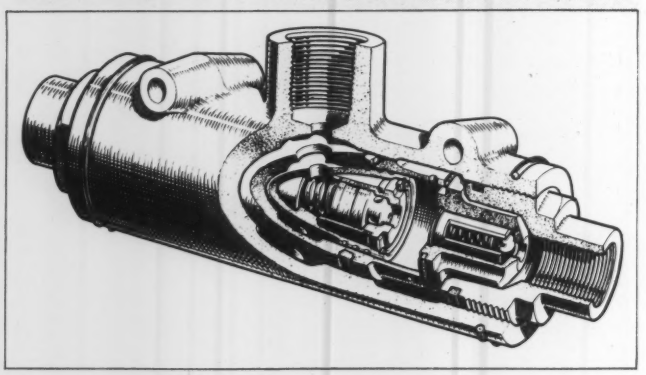


Fig. 9—Above—Flow divider, showing the method of incorporating the flow resistances from *Fig.* 8 in a basic design

Fig. 10—Below—An aircraft flow divider, developed originally to synchronize air brake action



tion, the design should use a reasonable pressure drop so that friction forces on the valve piston are small compared with the spring force. However, too high a pressure drop—apart from being wasteful of energy—causes exceptionally high dynamic flow forces on the piston at the reducing orifice. These forces, which arise from the drop in pressure in the orifice zone, tend to suck the valve shut. Practical designs must balance these factors.

Flow-Control Valves: Although a flow regulator or throttle can conveniently be used to regulate the output of a variable delivery pump, a different type of valve is needed to deal with the output of a constant delivery pump system. Here the total input of oil to the valve is constant and must be divided, one part being delivered at a constant rate down the required line and the remainder being returned to the reservoir or tank.

In order to maintain a constant flow rate down a line it is obvious that a fixed restrictor should be used together with means for by-passing excess input so that a constant pressure difference is once more maintained across the fixed orifice. This is achieved by using an orifice across which is a differential pressure-relief valve spilling into the by-pass line, *Fig.* 6*a*. The relief valve is held closed by its spring and outlet back-pressure; it is opened by inlet pressure. At all times, therefore, the pressure difference across the orifice is equivalent only to spring force and is thus constant, excess inlet flow being by-passed. In practice a flow-control valve need be little more complicated than is shown in *Fig.* 6*b*, although designers must take into account valve friction, dynamic flow forces and, in some cases, the effect of back pressure in the by-pass line which would upset regulation. *Fig.* 7 illustrates a typical practical design.

Flow Dividers: There is a special type of flow-control valve which divides the flow from one inlet pipe equally or in a constant ratio between two outlet pipes. This type of valve, originally developed for dividing the flow of viscose during the manufacture of rayon, is now used to synchronize the motion of

two motors or actuators independently of the back pressure which may exist in either line. Rotary units, generally consisting of two gear pumps coupled together and having a common inlet, have been used as flow dividers, but only valve devices achieving this object will be considered here.

The principle of operation of this type of valve is shown in *Fig.* 8. Oil enters the valve under pressure and passes through to the two work loads represented as resistances R_5 and R_6. Inside the valve are two resistances in each branch, R_1 and R_2 being fixed and R_3 and R_4 being variable. If $R_1 + R_3 + R_5$ equals $R_2 + R_4 + R_6$ the flow in each branch, and thus the motion of each actuator, will be equal. If R_5 increases, for example, due to an increase in the work load on this actuator, the flow down the branch will be reduced. What the valve must now do is automatically to reduce the resistance R_3, and preferably increase R_4 at the same time, until the sum of the resistances in each branch is once more equal.

A piston floating in a cylinder is connected after R_1 and R_2 as shown and its motion is arranged to vary R_3 and R_4 differentially. When the flow is equal the pressure on either side of this piston is equal, and it remains more or less central. If the flow in the left hand branch is decreased the pressure drop across R_1 decreases, and the piston will move to the right, increasing the resistance R_4 and decreasing R_3, which is the required result. In practice a very close degree of regulation—less than 2 per cent variation—can be obtained.

The diagrammatic construction of such a valve is shown in *Fig.* 9. A practical design, *Fig.* 10, shows a valve originally developed for synchronizing the motion of air brakes on aircraft. This valve, it will be noted, has check valves to allow free return flow.

If flow "multiplication" or "integration" instead of "division" is required, the same type of valve can be used, except that motion of the floating piston must operate the variable restrictors R_3 and R_4 in *Fig.* 8 in the opposite sense. In other words, motion of the piston to the right must increase R_4 and decrease R_3. How this is done is shown clearly in the diagrammatic valve in *Fig.* 11. The motion of two actuators can be synchronized with this type of valve by maintaining equality of the two return flows from the actuators back to the reservoir. Valves which have two sets of variable orifices and can act as dividers of forward flow and multipliers of reverse flow have sometimes been used.

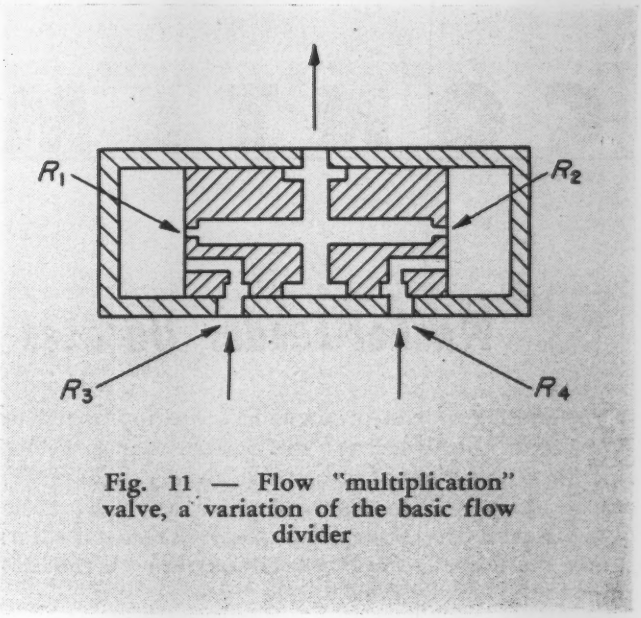


Fig. 11 — Flow "multiplication" valve, a variation of the basic flow divider

Flow dividers or multipliers can be very useful provided their inherent limitations are understood. There is always, for example, a starting error when flow begins, due to the time necessary for the piston to settle down. Thus, although the error in steady flow rates may be extremely small, there may be an initial position error of ¼ or ½ inch between the two actuators which will persist throughout their travel. The choking of an orifice will completely upset the regulation. The breaking of a pipe in one outlet branch of a flow divider, on the other hand, will not be apparent to the valve, which will continue to divide the flow and thus move only one cylinder. This can sometimes be embarrassing. And finally, if the cylinder seals develop a leak there may once again be a lack of true synchronism. Provided these drawbacks are understood, flow dividers or multipliers provide the engineer with an effective solution to a common problem.

Melting Aluminum in Air

EFFORTS of research engineers to prepare metals with higher purity have resulted in a technique resembling the Indian rope trick. Metals can now be melted in midair, literally floating in space. The technique developed by Westinghouse, involving the use of high-cycle induced currents, gets rid of volatile impurities in high melting point metals without contamination of the metal by contact with a refractory crucible.

The cold metal is placed between two slightly conical horizontal coils of copper spaced a few inches apart. As induced current of 10,000 cycles per second frequency is applied to the coils, the metal floats into the air midway between them. It then begins to spin furiously, glows red, begins to soften, and finally turns to a bright liquid which remains suspended, assuming the shape of a rapidly turning toy top. When the power is shut off the molten metal drops into a waiting crucible and solidifies almost immediately. With the new technique, the metal touches nothing except gas molecules. Thus metals can get rid of volatile impurities without absorbing others in the process. At the same time, alloying agents can be added to the molten metal while still suspended, with the induced currents providing thorough stirring of the resulting mass of alloyed material.

Washer-Feeder Uncases Bottles

ENTIRELY new in principle of operation, the RCA Victor bottle uncaser and washer loader, below, eliminates the manual operations usually required to remove bottles from returned cases and feed them into a washing machine. Schematic diagram, center, shows the flow of cases and bottles through the machine to the loading table.

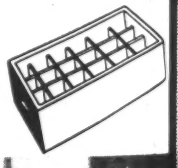
As shown in the flow diagram, cases entering the machine are turned over by a conveyor system which then passes the inverted cases over two transfer wheel assemblies. Each transfer wheel, shown in cross-section, has two rubber-faced rigid disks mounted between another pair of disks having pliable rubber outer sections. By a single screw adjustment built into the wheel hub, the disk spacing may be changed to suit different bottle and case dimensions.

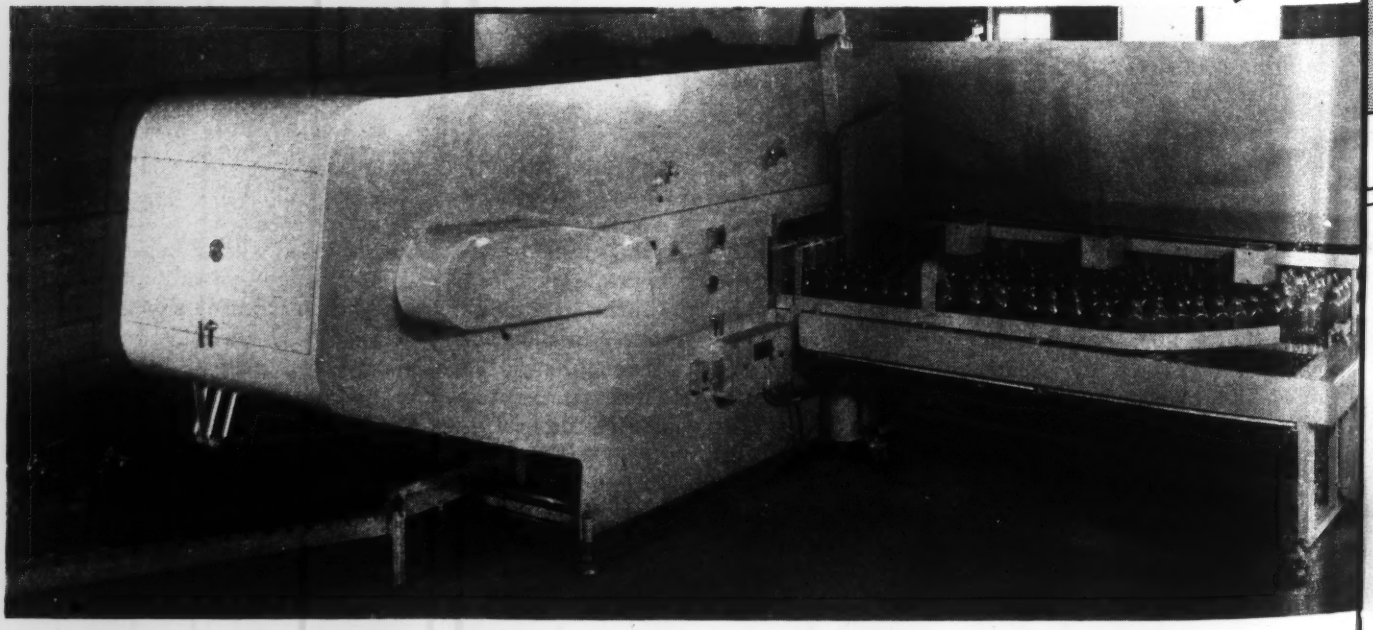
Parallel to and outside the pliable disks are stationary pressure plates, top, right, each containing a series of spring-loaded plungers which ride against and deflect the rubber disks inward to grip the bottles. Spacing of the plates and disks according to bottle size is indicated by calibrated scales mounted on the side panel of the machine.

As the inverted cases pass over the transfer wheels, the bottles are permitted to descend gradually into the spaces between the disks immediately ahead of the top clamping plungers. Descent of the bottles is controlled by their ends resting on pairs of Veelos idler belts mounted on arms extending between the disks, right, below. Depth of bottle engagement in both wheel units is adjusted simultaneously by a plunger positioned control linkage which determines the angular setting of the arms.

Proceeding into the transfer wheels, the bottles are gripped between the disks and carried around to the bottom station where, after passing the last clamping plunger, they are released right-end-up onto a flat chain conveyor. Guideplates distribute the bottles over the conveyor to the washer-loader table where they are spread to fill a series of loading channels. If at any time the delivered bottle supply exceeds the washing machine requirement, permitting the loader table to become full, a limit switch automatically stops the uncaser to avoid jamming.

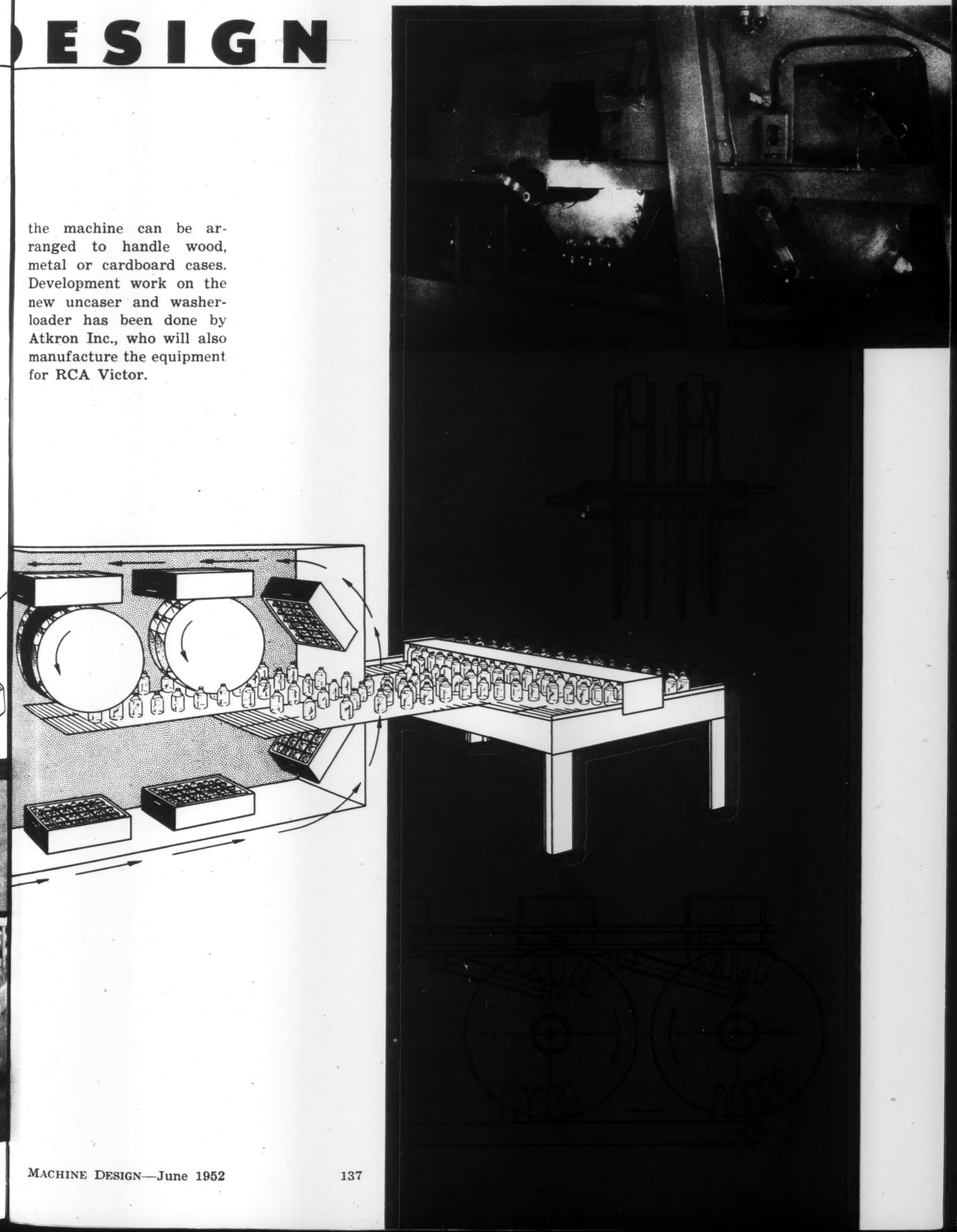
Capable of delivering up to 576 bottles per minute,

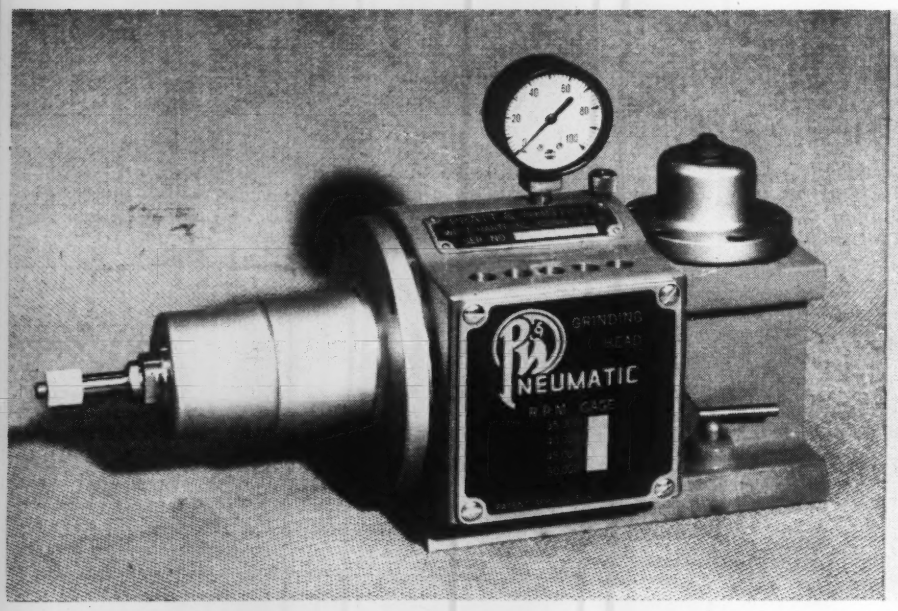


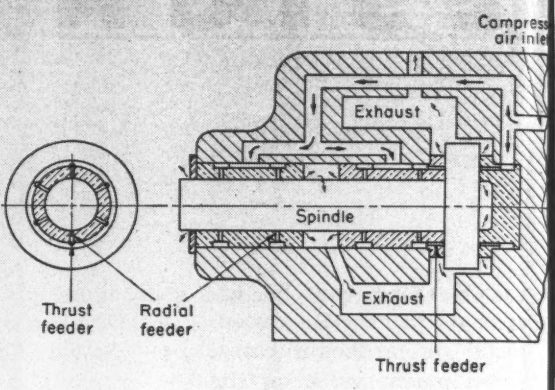


DESIGN

the machine can be arranged to handle wood, metal or cardboard cases. Development work on the new uncaser and washer-loader has been done by Atkron Inc., who will also manufacture the equipment for RCA Victor.







Air Lubricates Grinder Head Bearings

SIMPLE air lubrication of spindle journals and thrust bearings in a new air-driven internal grinding head, above, left, results in multiple benefits including: true running characteristic of plain bearings with minimum frictional loss of power, low temperature of operation enabling use of close running clearances, uniform efficiency over a wide speed range, low maintenance cost because of few moving parts, and freedom from vibration.

Rotating in Bearium bushings containing radial and thrust airfeed grooves, above, right, the stainless steel spindle and aluminum rotor are reported to indicate virtually no speed limitation since the unit functions as well or better at 100,000 rpm as at lower speeds. With reasonably clean air supply, bearing life is expected to be indefinite, because the rotating parts actually are suspended in air. In addition to the usual line filter recommended, a secondary filter is built into the spindle housing to protect the bearings and control mechanism.

Also contained in the spindle housing are; a lever operated "on-off" valve which is operable beyond the "off" position to brake the spindle, a pressure regulating valve to eliminate effect of line pressure fluctuations, a needle valve to set the spindle speed, and a centrifugal speed governor control mounted at the inner end of the spindle. At the speed determined by needle valve adjustment, multiple cantilevers of the governor unseal a control orifice causing throttle response to prevent further increase in speed. Constant speed under load is assured by automatic regulation of the orifice which varies turbine nozzle pressure as required to maintain the preselected speed.

A pressure gage mounted on the head indicates nozzle pressure, and in conjunction with stamped pressure ratings on the nameplate simplifies the selection of nominal free speeds. The gage also serves as an indicator of contact between the work and grinding wheel, and can be used to advantage in duplicating work size within 0.0001-inch when used in conjunction with an automatic feed control.

Built by Pratt and Whitney division of Niles-Bement-Pond Co., two models of the new design have been announced; one for 35,000 to 50,000 rpm and the other for 60,000 to 100,000 rpm. Air requirement of the heads ranges from 25 to 36 cfm. The housing base is machined for dovetail mounting in machine slides.

Indicator Records Dynamic Forces

ACCURATE documentary proof of dynamic forces is possible in the Graphotest recording indicator, right, top. Below this illustration is shown a typical function of the instrument where the cutting force of a lathe tool is being recorded. In this application, the tool bit is mounted on a diaphragm, the deflection of which is measured by the instrument to determine cutting force of the tool.

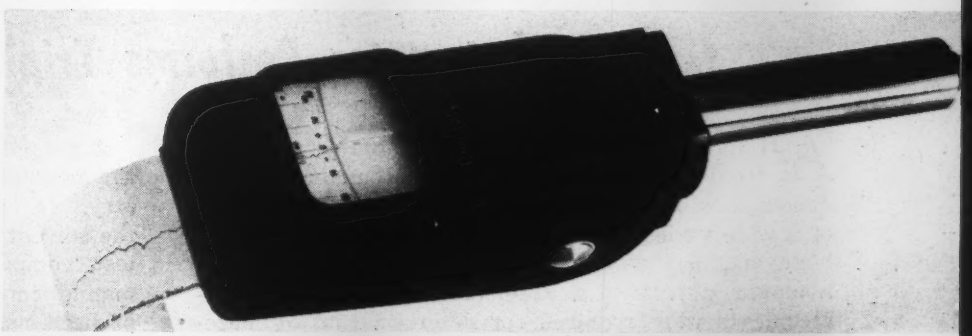
Compact arrangement of the measuring and recording elements is evident in the cross-section drawing, right, taken through the center of the case. Pressure against a feeler tip causes a lightweight glass

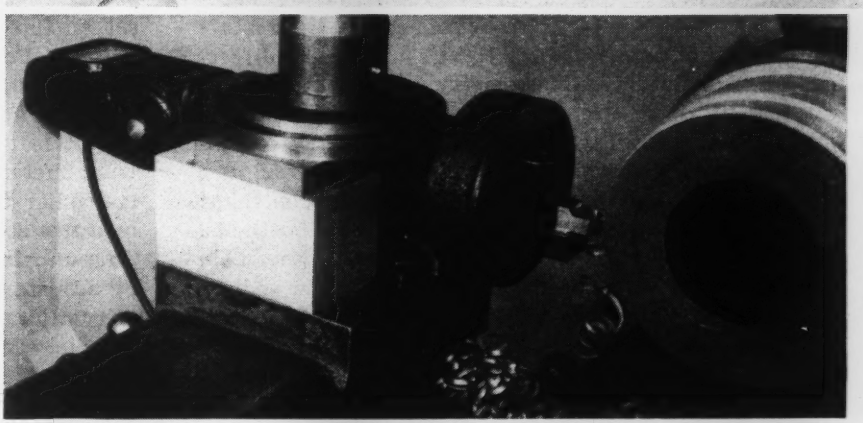
indicator needle, which is also the recording pen, to swing in magnified response to an applied force. Transmission of motive force to the pen is through leaf springs, thus avoiding friction and lost motion in the mechanism. Fulcrum of the pen is located so that the pen will record also when the instrument is used in a vertical position.

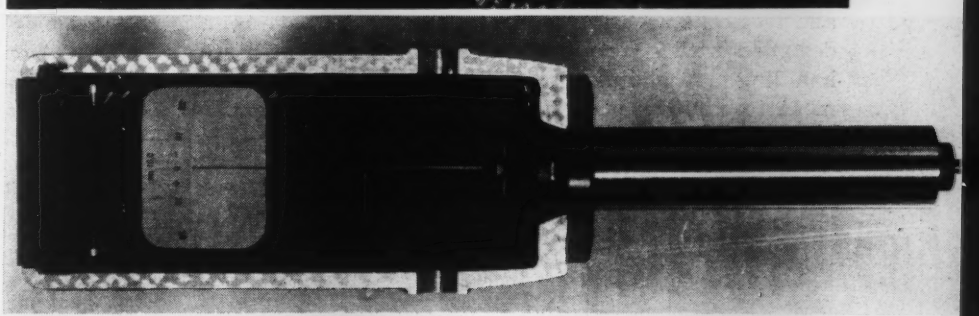
The measuring components are assembled, complete, in a tube attached to the top half of a split-housing, right, center (bottom view). Bottom half of the housing, above drawing, contains the paper roll and transport mechanism. Sprocket holes are not required in the paper stock for feeding and timing purposes. Instead, the paper is driven by a unique traction roll through the penetration of needles extending from a series of involute-shape pins located in a necked section in the center of the roll. The holes thus pierced in the paper establish a zero line for reference in evaluating the diagram.

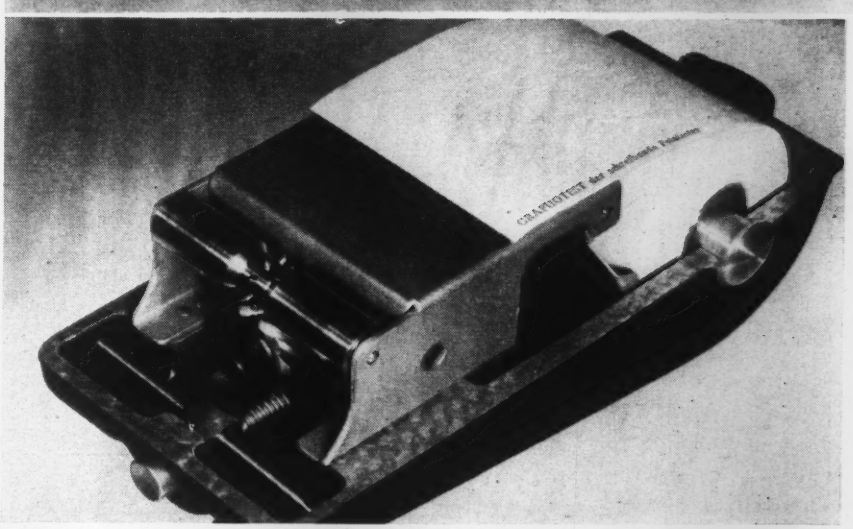
The involute sprocket pins mesh with a driving worm carried on the shaft extension of a miniature synchronous-motor drive. By interchangeable worms, the paper drive ratio can be varied in 24 successive steps. In addition, alternative fixed-gear drive ratios also are available for slow, medium, or fast paper speeds. The housing halves are held together by a retaining clip and spring-loaded latch rod arrangement operated by push-button.

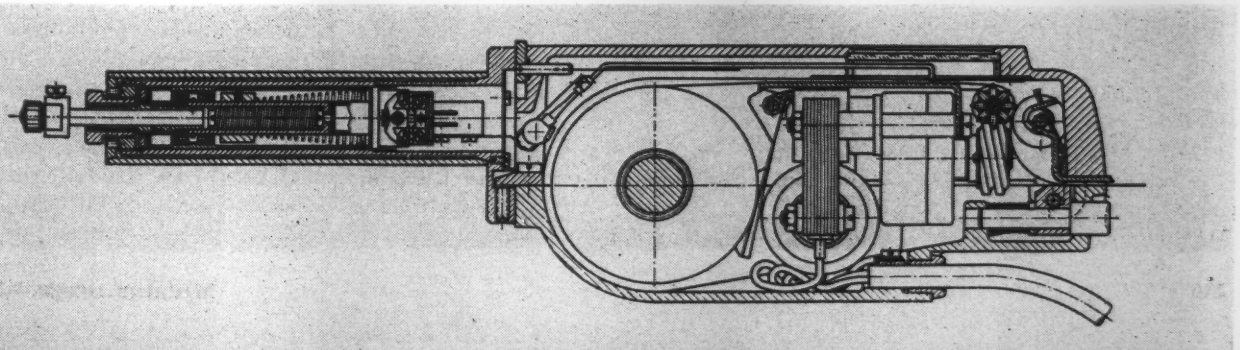
Made in Germany by Schoppe and Faeser, the instrument is available in 100, 200, and 250X magnification capacities with respective measuring ranges of 0.5, 0.25, and 0.20 millimeters. Measuring force is about 160 grams and the indicating errors are of the order of plus or minus one micron.











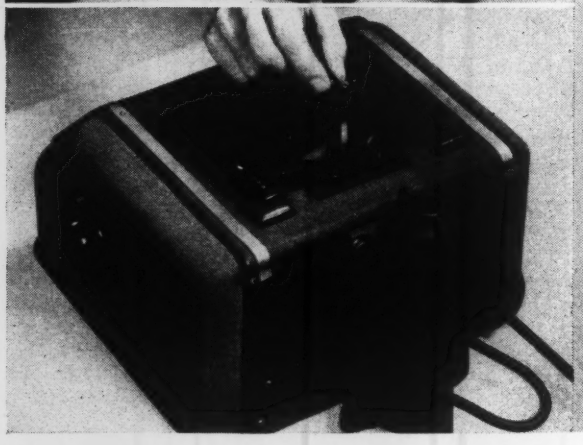
Photometer Performs Triple Analysis

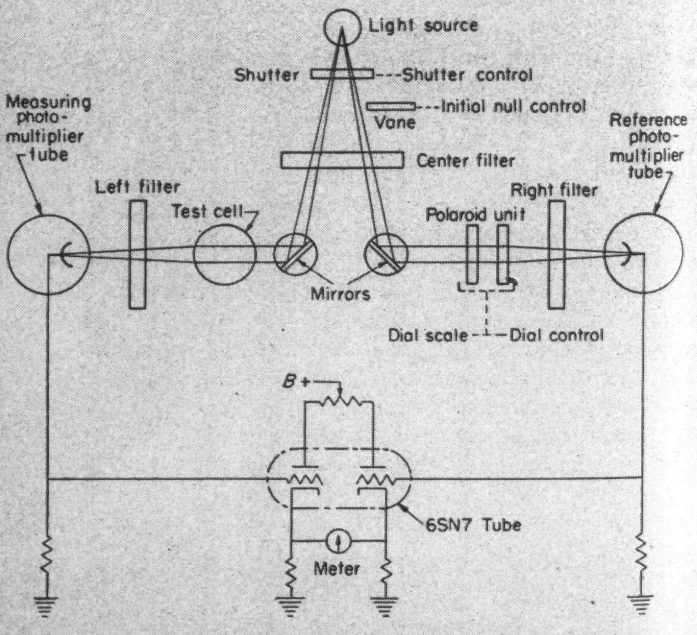
AN INGENIOUS arrangement of optics and electronics in the Nefluoro-Photometer, below, makes possible the rapid detection and measurement of a wide variety of organic, inorganic, synthetic, and biological materials by any one of three methods in a single instrument. Previously, three separate instruments were required for determination of materials by: nephelometry (measurement of light scattered at right angles from a light source beam directed at a solution), fluorometry (measurement of fluorescent light emitted from a solution, at right angles to the incident beam), and colorimetry (measurement of light transmittance directly through a test solution). A complete analytical operation takes less than 60 seconds by any of the three methods.

To permit convenient interchange of three available light sources, incandescent, mercury arc, or sodium arc, the lamp housing, bottom, is plug-connected and attached to the back of the instrument by knurled thumbscrews. This arrangement effectively isolates lamp heat from the test cell. Filter slides, mirrors, and test cells used for conducting the tests, have been designed with convenient knobs or grips to facilitate handling. A sliding shield covers the cell compartment to exclude daylight from the optical system.

A simplified schematic diagram, below right, shows the instrument setup for testing a solution by colorimetry. In this operation, a transparent cell filled with the solvent to be used for the solution is placed in the test compartment, and the instrument is set by manual control for optimum sensitivity to the amount of light passed by the solvent. Next a dial scale is set at 100 per cent, in which position a pair of adjustable Polaroid lenses are set automatically to allow maximum transmission of a reference light beam. Adjustment of a control rheostat in the electronic circuit is then made to balance, at zero, a voltmeter (null meter) indication of light entering two photomultiplier tubes. The clear solvent is then replaced by a test solution, which naturally transmits less light. This unbalances the voltmeter which then is re-zeroed by adjustment of the Polaroid unit to reduce the light intensity on the reference phototube. Calibrations on the dial scale of the Polaroid control indicate the percentage of light transmittance which is then related to the concentration.

Made by the Fisher Scientific Co., the instrument operates on 115-volt ac, and has a built-in constant voltage transformer which stabilizes the operating current within one per cent.





STAINLESS-CLAD COPPER

. . . promises improved high-temperature service

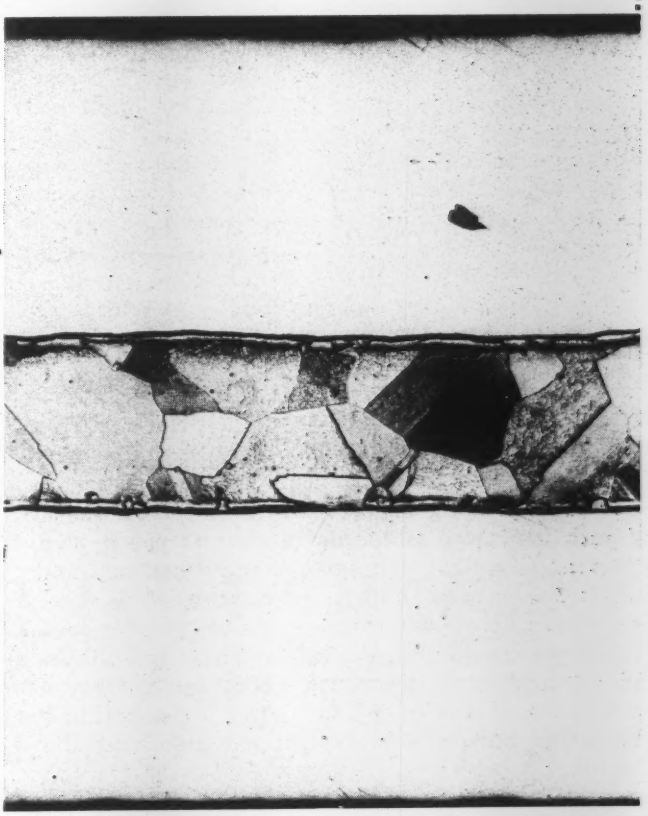


Fig. 1—Photomicrograph etched to show the copper core material between two sheet of stainless steel. Magnification, about 100 times

A COPPER "sandwich" consisting of a copper core clad with stainless steel, *Fig.* 1, may boost jet engine service life and performance by giving heat-resisting alloys better thermal conductivity. Called Rosslyn Metal, this composite sheet material is the development of American Cladmetals Co. To test its high-temperature behavior in jet and piston engine applications, Ryan Aeronautical Co. is building combustion chambers, afterburner vanes and exhaust headers of this laminated materal.

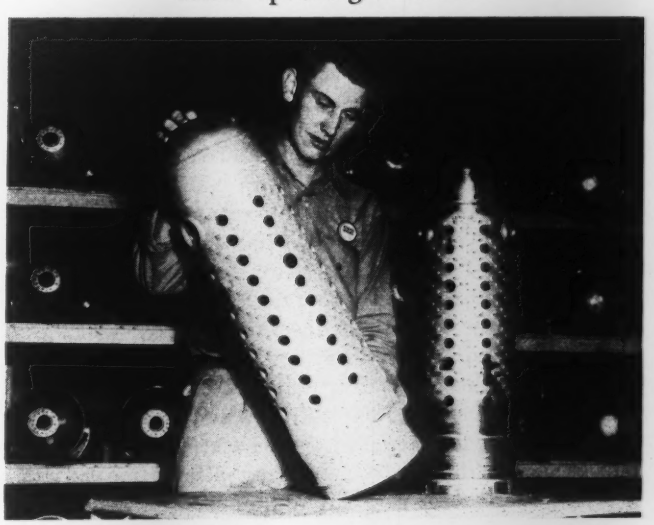
Blending the heat-conducting qualities of copper with the strength and durability of stainless steel, this sandwich material has the highest thermal conductivity of any heat-resisting material. Even at temperatures of 1500 F, lateral conductivity compares favorably with pure copper which would, of course, oxidize to destruction if exposed directly to such heat.

These laminated sheets have a comparative thermal conductivity of 57.2 per cent, based upon copper's 100 per cent. When heat penetrates any point of the thin stainless steel outer walls, the copper core quickly and uniformly conducts it throughout the entire sheet. Thus hot spots are avoided.

Such thermal properties may substantially improve performance of high-temperature components by eliminating stresses which are incurred between hot, expanded areas and the surrounding, cooler metal. These stresses can produce ruptures in the metal and are greatly aggravated by poor thermal conductivity and high coefficients of expansion.

Jet engine components and exhaust manifolds must operate at extreme temperatures ranging on the high side from 1300 to 1900 F. Combustion chambers, transition liners, tail cones and exhaust systems are fabricated from stainless steels, Inconel and other chrome-nickel alloys which have high corrosion resistance but inherently poor heat conductivity. With copper rated at 100 per cent, stainless steel would receive a slim 6.1 per cent in thermal conductivity. The effects of hot flame impingement plus poor

Fig. 2—High-temperature tests for the sandwich material will be conducted with these jet engine combustion chambers. Standard chamber, right, will be compared with stainless clad copper chamber, left, under actual operating conditions



thermal conductivity, encountered under service conditions, tend to cause warping and buckling of the thin-walled structures and are limiting factors in their design.

In service, temperature differentials of as much as 1400 F have been observed with metals such as Inconel X, N-155 and Hastelloy C. Under similar conditions, alloys of higher conductivity have exhibited a differential of only 400 to 450 F. Temperature gradients are primarily a function of thermal conductivity.

To test the advantages of the new material for combustion chambers, *Fig.* 2, Ryan has fabricated chambers from two types—321 stainless steel clad and 1010 mild steel clad. These chambers are being service tested and the results will be compared with those obtained from standard chambers of Inconel. In the piston engine field, Ryan has built exhaust system headers from 19-9D1 stainless-clad copper and these components have been placed on actual airliner test installed on 3500 hp Pratt and Whitney R-4369 Wasp Major power plants.

The sandwich material can be handled in production in much the same way that the stainless steel or Inconel material alone is processed. It can be formed, welded, machined and spun without difficulty if attention is paid to its particular characteristics.

Two outstanding benefits may result from the use of such laminated materials in aircraft power plants —saving in weight and savings in critical materials. About five pounds of high temperature alloy is used in a typical combustion chamber and each jet engine employs approximately eight chambers as well as a similar number of transition liners and a large exhaust cone assembly and tail pipe. Substituting the composite material for straight chrome-nickel alloys would save 30 per cent of the scarce nickel, chromium, columbium and other metals in these components.

Weight saving is accomplished by taking advantage of superior lateral heat spreading qualities and using thinner sheet than would normally be possible with metals having poorer thermal conductivity. Extra thickness to combat the ravages of hot spotting would not need to be specified. Sheet thicknesses with sufficient strength for the application would be the limiting factor in going to lighter material.

For purposes of approximation, it has been determined that the percentage of reduction in rupture strength at 1500 F of the copper core material over solid stainless steel is about half of the percentage of copper in the material. For instance, if the sheet is 30 per cent copper, rupture strength reduction at 1500 F will be about 15 per cent.

Laboratory data show that strength at temperatures up to 500 F is at least equivalent to that of a sheet of solid stainless steel having a thickness equal to the laminated sheet less two-thirds the thickness of its copper core. For temperatures ranging between 500 and 1500 F the two-thirds factor becomes one-half, because the new material is relatively stronger at these higher temperatures. Thus, with standard 30 per cent copper core, 85 per cent of the total thickness may be used in design calculations with the rated strength of the cladding material at temperatures between 500 and 1500 F.

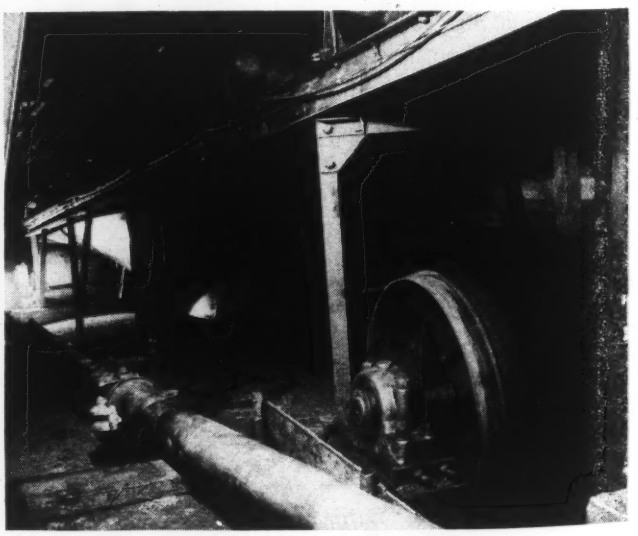
With these favorable factors, the sandwich material may well become the next metallurgical step to increased jet engine performance because it could provide for higher operating temperatures as well as longer life. An increase of only 100 F in the operating temperature of a gas turbine would improve thermal efficiency as much as 30 per cent.

"Turnover" Conveyor for Sticky Loads

WET or sticky materials present a problem when carried on conventional conveyor belts since, on the return run, a damaging buildup of tacky material is likely to occur on idlers or pulleys. Outdoor conveying in winter is especially difficult, with subzero temperatures causing the belt to freeze to the idlers.

In a new "turnover" belt conveyor system developed jointly by B. F. Goodrich and the Chain Belt Co., the belt is twisted 180 degrees at each end of the conveyor system. Thus, the clean side of the belt is presented to both carrying and return idler rollers. The first conveyor of this type has been installed in an underground iron mine near Ishpeming, Mich., for carrying iron ore to surface stockpiles.

Belt "turnover" action is accomplished by positioning two twist pulleys at each end of the system. Any spillage from the top conveying run on to the lower return run is carried to the tail end and automatically dumped at the twist pulleys, to be subsequently reclaimed. In addition to messy or sticky materials, such as phosphates, raw sugar and lignite, corrosive materials which attack the metallic understructure can be handled.



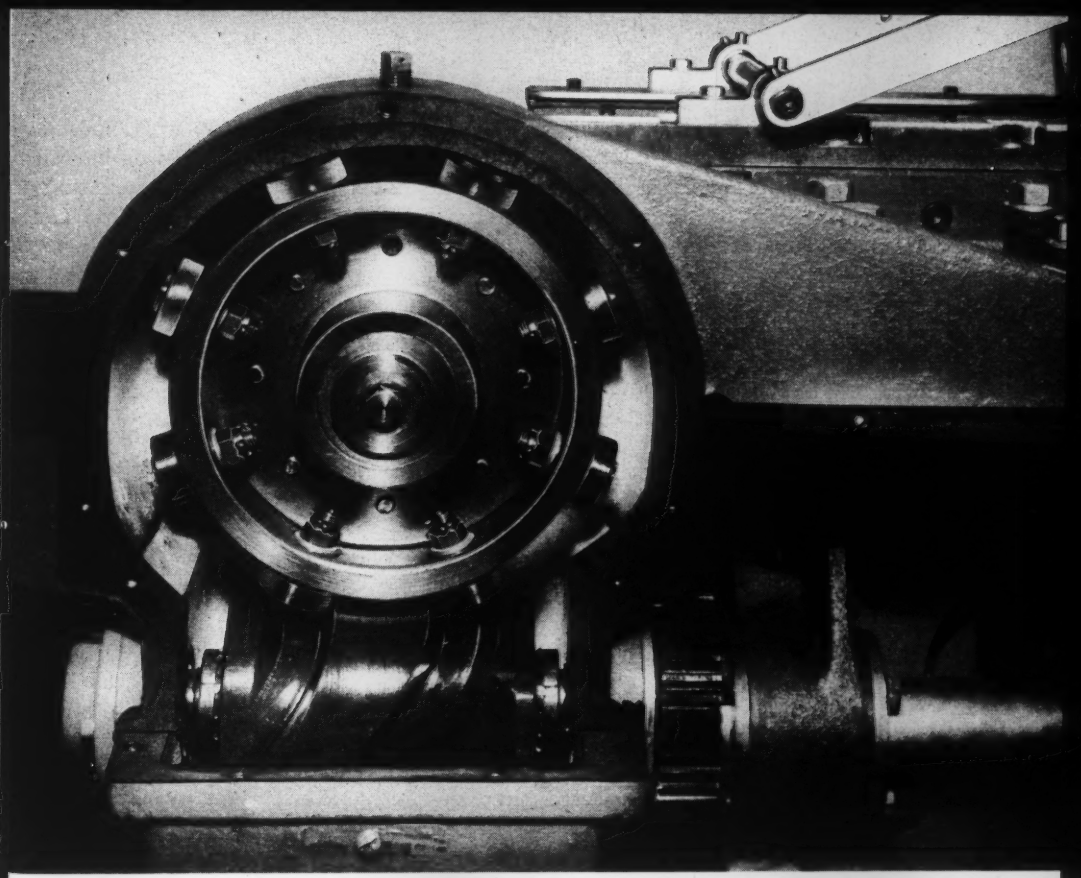


Fig. 1—Roller Gear Drive for automatic machine with 8 rollers and 8 stops per revolution of the gear. Indexing period is 180 deg of cam rotation; cam speed, 240 rpm

DESIGNING CAMS

. . . for controlled inertia and vibration

By C. N. Neklutin

Chief Engineer and Vice President
Universal Match Corp.
St. Louis, Mo.

DURING the last quarter of a century, mechanization of manufacturing plants has proceeded at a faster and faster rate. The relatively young paper match industry, with which the author has been associated for the past twenty-five years, began with highly automatic machinery that has been constantly refined and speeded up to lower operating costs in the face of growing competition. *Fig.* 1 shows a typical cam drive of the type that has provided higher speed operation.

As every designer knows, with an increase of speed, dynamic forces begin to be a controlling factor. Acceleration and deceleration of moving parts create inertia forces which change from plus maximum to minus maximum. The application of inertia forces and the reversal of them create vibrations, which in turn decrease the efficiency of the machines, increase maintenance, and affect the quality of the product. The control of acceleration of moving parts in automatic machines has become a problem of primary importance. At the same time, a better knowledge of the kinematics of different mechanisms is essential in the selection of a device most suitable for producing a certain movement in the machine. In order to assess the effects of inertia forces, it is necessary first to express the accelerations produced by various

devices in a manner allowing easy comparison between them.

In practically every automatic machine cams are used since they permit production of the most useful irregular motions and the designer can control the characteristics of the movement produced by them. Twenty-five years ago, cams were distinguished by their shape—logarithmic curve, arcs of the circle connected by straight lines, elliptical curve, etc. They were laid out on a pattern and machining was done by following the lines. Little attention was paid to the acceleration produced by these shapes, with one exception: the cam with uniform acceleration, which was considered the best because it provided the lowest possible acceleration.

Even before the theory of vibrations was fully developed, it was known that a suddenly applied force could produce stresses and deflections twice as great as the stresses produced by a static force of the same magnitude. And, in the case of uniform acceleration, the inertia force was applied suddenly, then it changed from plus maximum to minus maximum instantaneously, and finally it was removed in the same way. Therefore, it could be expected that the actual dynamic stresses were considerably greater than the stresses caused by static forces of the same magnitude.

As a possible step forward, it occurred to the author that a cam should be designed by selecting first the acceleration diagram which is the most suitable for producing the motion desired. Then the velocity diagram and the displacement chart could be determined mathematically by integration. Thus a cam might be cut to produce the most desirable acceleration of moving parts.

At that time, strain gages and accelerometers suitable for analyses of short movements were not available. So the idea was tried on existing machines by replacing "laid-out" cams with "calculated" cams which, supposedly, produced acceleration without abrupt variations. The results were gratifying. Some machines were speeded up 40 per cent with improved efficiency, and the limit was set by the ability of operators to pack the product. Multicolor printing presses using an intermittent motion to feed paper web were speeded up 20 per cent; further increase of speed was barred by breakage of crank shafts operating the printing heads due to fatigue of the metal. At the same time, the register of printing was improved as the stretching of the web was decreased. New automatic machines were designed, and eventually they were speeded up to a rate twice that of the replaced machines.

The movements used in automatic machines can be divided into three groups:

1. *Dwell-Rise-Dwell:* Movements which start from a rest period and end at a rest period, so that each stroke is produced between two periods of dwell
2. *Dwell-Rise-Return-Dwell:* Forward and return strokes having no dwell between them, but having a dwell after the return stroke
3. *Rise-Return-Rise:* Forward and return strokes following each other without a dwell.

Dwell-Rise-Dwell Movement: This first group represents the simplest movements utilized in automatic machines. Discussion of them includes analysis of different acceleration diagrams which can be presented by simple mathematical equations and provides a method of acceleration comparison. This method can be applied also in most cases to mechanisms other than cams, so that properties of their movements can be compared with properties of theoretical acceleration diagrams applicable to cams. Results of this analysis can be applied to the movements of the second and third groups.

In writing equations for acceleration, velocity, and displacement, it is important to introduce into them the data which directly confront the designer, such as: stroke of the movement, expressed in inches; speed of the driving shaft, expressed in revolutions per second; and the angle through which this shaft rotates while producing the stroke, expressed in degrees.

The movements can be lineal or angular; the latter are quite often used for intermittent motion when no return stroke exists. If the total lineal displacement is designated as S inches and the total angular displacement in case of an intermittent motion as $2\pi/n$, where n indicates the number of stops made by the

CAM DESIGN becomes increasingly challenging as ever higher operating speeds are demanded. Instrumental for more than 25 years in developing high-speed automatic equipment for the match industry, the author reveals in this article a proved method of design that can be applied to all types of cams requiring strict control of kinematic properties. He summarizes pertinent information on inertia and vibration phenomena in cam operation and presents in detail a practical procedure for limiting their destructive effects. Inventor of the Ferguson Roller Gear Drive, Mr. Neklutin is an authority on high-speed indexing, an application of one of the three types of cam action discussed in this article

driven shaft while it makes one revolution, then the angular movement can be replaced by the lineal displacement:

$$S = \frac{2\pi}{n} r \quad \ldots\ldots (1)$$

where r is the radius of the point which has the lineal displacement S.

The analysis is made for lineal movements, but in the final equations it is possible to replace S by $2\pi/n$ to display the results in radians instead of inches.

It is assumed that the cam has to produce the stroke S and that the timing of the machine presents only one requirement: the distance S should be traveled during a certain period of time.

If the speed of the drive shaft is N rps and the stroke should be performed while the shaft turns through α degrees, then the time allowed for the movement is:

$$T = \frac{\alpha}{360}\,\frac{1}{N} = \frac{1}{\frac{360}{\alpha} N} \text{ sec} \quad \ldots\ldots (2)$$

Angle α will be called the *working period,* expressed in degrees.

The equation for acceleration, a, can be written in the form:

$$a = \frac{S}{T^2} f_a(t) \quad \ldots\ldots (3)$$

where the variable t is time.

The expression S/T^2 is measured in inches per sec^2 or in the same units as the acceleration; therefore, the function $f_a(t)$ is a dimensionless expression which varies from zero to plus maximum, then it changes to minus maximum and back to zero. This function can be called the *coefficient of acceleration* and it is characteristic for each acceleration diagram.

Four values of the coefficient of acceleration are important for comparing and judging different acceleration diagrams:

c_b = coefficient at the beginning of the movement
c_f = coefficient at the end of the movement
C_a = coefficient of maximum acceleration
C_d = coefficient of maximum deceleration

Usually $c_b = -c_f$ and $C_a = -C_d$

Introducing the value of total time T from Equation 2 into Equation 3 and leaving on the right-hand side only $f_a(t)$,

$$\frac{a}{S\left(\frac{360}{\alpha} N\right)^2} = f_a(t) \quad \ldots\ldots (4)$$

In this expression all items which describe fully the conditions of the movement—stroke, working period, and speed of the driving shaft—are removed from the expression of the acceleration. Such an expression, written for different acceleration diagrams, allows comparison between them. The magnitude of $f_a(t)$ for any given profile is the same as would be obtained if the displacement were assumed to be unity, occurring in unity time.

Equation 4 shows clearly that the acceleration, or the inertia force created by it, is proportional to the stroke and the square of the shaft speed and inversely proportional to the square of the working period.

The principal aim of the designer is to increase the speed N of the machine, and he can accomplish it by selecting an acceleration diagram with low value of the coefficient of acceleration and by manipulating the relation between the stroke S and the working period α.

An increase of the stroke may create a greater clearance between the interfering parts of the machine, so the movement of the machine part under consideration can be started before the motion of the interfering part ends. In this way α can be noticeably increased, especially where acceleration is low at the start and at the finish of the stroke because in this case the displacements at both ends of the stroke are small. As a result, the acceleration can be decreased because S enters into the expression for acceleration in the first power while α is in the second power.

If the designer knows the coefficient of maximum acceleration, C_a or C_d, of a selected diagram, he can determine the acceleration by multiplying this coefficient by the expression $S(360N/\alpha)^2$ in inches per sec^2. All components of this expression are known to him. The inertia force F in pounds is found as the product of the acceleration a in inches per sec^2 and the mass of moving parts:

$$F = \frac{W}{g} a$$

where W is the weight of the parts, lb, and g is the gravitational acceleration, inches per sec^2.

The equation for velocity also can be written in a similar form:

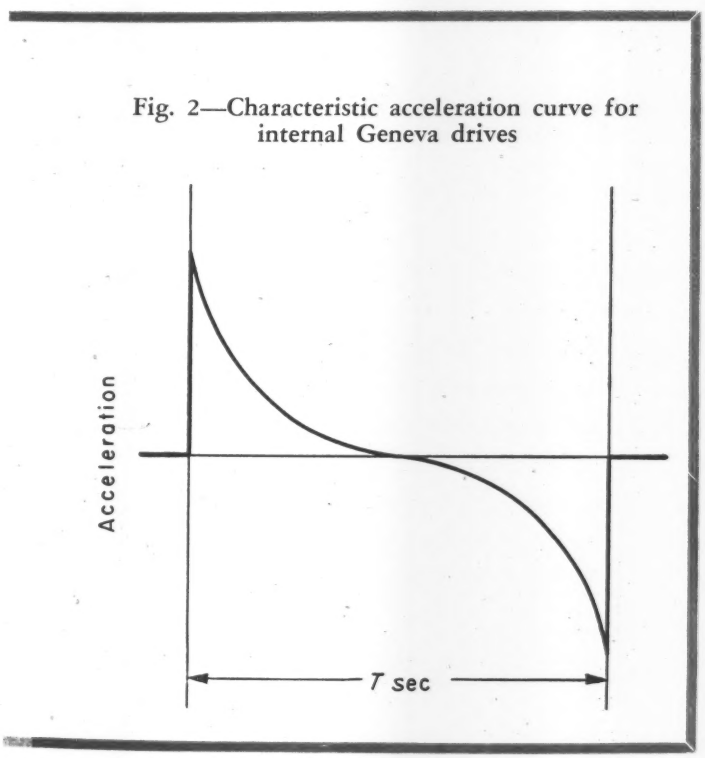
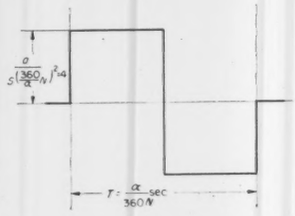
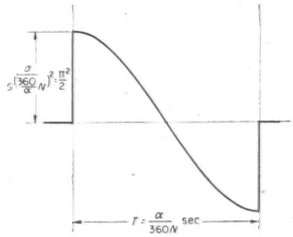
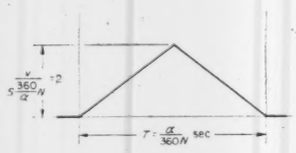
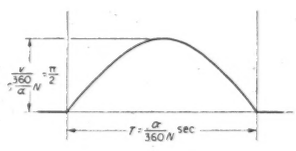


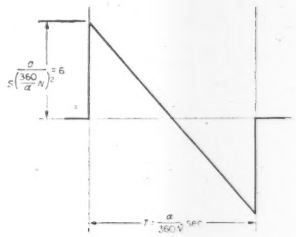
Fig. 2—Characteristic acceleration curve for internal Geneva drives

Table 1—E

	UNIFORM ACCELERATION	COSINE CURVE ACCELERATION
Acceleration	 $\dfrac{a_1}{S\left(\dfrac{360}{\alpha}N\right)^2} = +4;\ \dfrac{t}{T} = 0 \text{ to } 0.5$ $\dfrac{a_2}{S\left(\dfrac{360}{\alpha}N\right)^2} = -4;\ \dfrac{t}{T} = 0.5 \text{ to } 1.0$ $c_b = C_a = -C_d = -c_f = 4$	 $\dfrac{a}{S\left(\dfrac{360}{\alpha}N\right)^2} = \dfrac{\pi^2}{2}\cos\pi\dfrac{t}{T};\ \dfrac{t}{T} = 0 \text{ to } 1;$ $c_b = C_a = -C_d = -c_f = \dfrac{\pi^2}{2} = 4.935$
Velocity	 $\dfrac{v_1}{S\left(\dfrac{360}{\alpha}N\right)} = 4\dfrac{t}{T}$ $\dfrac{v_2}{S\left(\dfrac{360}{\alpha}N\right)} = -4\left(1-\dfrac{t}{T}\right)$ $C_v = 2$	 $\dfrac{v}{S\left(\dfrac{360}{\alpha}N\right)} = \dfrac{\pi}{2}\sin\pi\dfrac{t}{T}$ $C_v = \dfrac{\pi}{2} = 1.571$
Displacement	$\dfrac{s_1}{S} = 2\left(\dfrac{t}{T}\right)^2$ $\dfrac{s_2}{S} = 4\dfrac{t}{T} - 1 - 2\left(\dfrac{t}{T}\right)^2$	$\dfrac{s}{S} = \dfrac{1-\cos\pi\dfrac{t}{T}}{2}$
Vibrations	$\dfrac{\delta_v}{\delta_s}C_a = C_a\,2(1-\cos\pi m)\cos\pi m\left(\dfrac{t}{T}-1\right)$ $\dfrac{t}{T} \geq 1$ When $m = T/t$ is an even number, $(\delta_v/\delta_s)\ C_a = 0$. When m is an odd number, $(\delta_v/\delta_s)\ C_a$ reaches a maximum value $= \pm 4C_a = \pm 16$.	$\dfrac{\delta_v}{\delta_s}C_a = C_a\left(\dfrac{4m^2}{4m^2-1}\right)\times$ $\left[\cos 2\pi m\dfrac{t}{T}(\cos 2\pi m + 1) + \sin 2\pi m\dfrac{t}{T}\sin 2\pi m\right]$ The expression $4m^2/(4m^2-1)$ is > 1, and it approaches unity when m increases. When m is a full number $\pm$ ½, then $\delta_v/\delta_s = 0$. When m is a full number, vibrational stresses reach a maximum value $\delta_v/\delta_s \geq 2$; then $(\delta_v/\delta_s)\ C_a \geq \pm 9.87$.

-Equations and Vibration Analysis for a Group of Simple Acceleration Diagrams

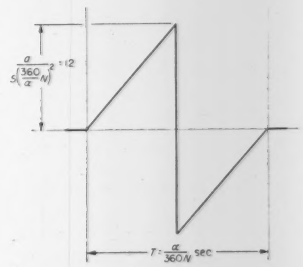
TRIANGULAR ACCELERATION I



$$\frac{a}{S\left(\frac{360}{\alpha}N\right)^2} = 6\left(1 - 2\frac{t}{T}\right);\ \frac{t}{T} = 0 \text{ to } 1;$$

$$c_b = C_a = -C_d = -c_f = 6$$

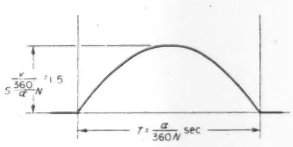
TRIANGULAR ACCELERATION II



$$\frac{a_1}{S\left(\frac{360}{\alpha}N\right)^2} = 24\frac{t}{T};\ \frac{t}{T} = 0 \text{ to } 0.5$$

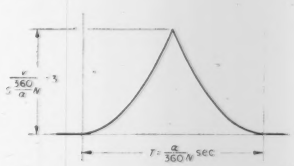
$$\frac{a_2}{S\left(\frac{360}{\alpha}N\right)^2} = 24\left(1 - \frac{t}{T}\right);\ \frac{t}{T} = 0.5 \text{ to } 1$$

$$c_b = -c_f = 0;\ -C_d = C_a = 12$$



$$\frac{v}{S\left(\frac{360}{\alpha}N\right)} = 6\frac{t}{T}\left(1 - \frac{t}{T}\right) = C_v 4\frac{t}{T}\left(1 - \frac{t}{T}\right)$$

$$C_v = 1.5$$



$$\frac{v_1}{S\left(\frac{360}{\alpha}N\right)} = 12\left(\frac{t}{T}\right)^2$$

$$\frac{v_2}{S\left(\frac{360}{\alpha}N\right)} = 12\left(1 - \frac{t}{T}\right)^2$$

$$C_v = 3$$

$$\frac{s}{S} = 3\left(\frac{t}{T}\right)^2 - 2\left(\frac{t}{T}\right)^3$$

$$\frac{s_1}{S} = 4\left(\frac{t}{T}\right)^2$$

$$\frac{s_2}{S} = 4\left(\frac{t}{T}\right)^3 - 12\left(\frac{t}{T}\right)^2 + 12\left(\frac{t}{T}\right) - 3$$

$$\frac{\delta_v}{\delta_s} C_a = C_a \left\{ \sin 2\pi m \frac{t}{T} \times \left[\frac{1}{\pi m}(1 - \cos 2\pi m) - \sin 2\pi m \right] - \cos 2\pi m \frac{t}{T} \times \left[(1 + \cos 2\pi m) - \frac{1}{\pi m} \sin 2\pi m \right] \right\}$$

When m is small, δ_v/δ_s maximum is $> \pm 2$, and this happens when m is close to a full number, as $m = 7/8$ or $1\frac{3}{4}$, etc. The ratio δ_v/δ_s never reaches zero when m varies, but its minimum value at each m decreases with an increase of m. When m is large, δ_v/δ_s maximum approaches ± 2, and the appearance of maximum vibration with change of m is cyclic. When m is a full number, $(\delta_v/\delta_s)\ C_a \geq 12$.

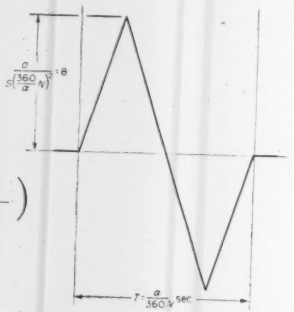
$$\frac{\delta_v}{\delta_s} C_a = C_a 2\left(1 - \frac{1}{\pi m}\sin \pi m\right) \times \left(\cos 2\pi m \frac{t}{T} \cos \pi m + \sin 2\pi m \frac{t}{T} \sin \pi m\right)$$

Maximum vibration stresses are never equal to zero. The ratio δ_v/δ_s varies approximately from 1.9 to 2.1, while m changes by 2. When m increases, the variation of δ_v/δ_s decreases and its value approaches 2. When m is a whole number, $(\delta_v/\delta_s)\ C_a = \pm 24$. Maximum value $= (\delta_v/\delta_s)\ C_a \geq \pm 24$.

ISOSCELES TRIANGLE ACCELERATION

$$\frac{a_1}{S\left(\frac{360}{\alpha}N\right)^2} = 32\,\frac{t}{T}$$

$$\frac{t}{T} = 0 \text{ to } 0.25$$



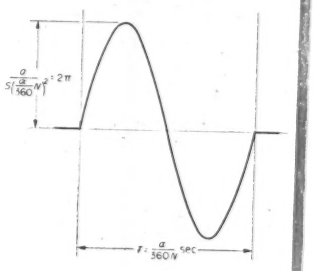
$$\frac{a_2}{S\left(\frac{360}{\alpha}N\right)^2} = 16\left(1 - 2\,\frac{t}{T}\right)$$

$$\frac{t}{T} = 0.25 \text{ to } 0.75$$

$$\frac{a}{S\left(\frac{360}{\alpha}N\right)^2} = -\,32\left(1 - \frac{t}{T}\right);\ \frac{t}{T} = 0.75 \text{ to } 1$$

$C_b = -\,C_f = 0;\ C_a = +\,8;\ C_d = -\,8$

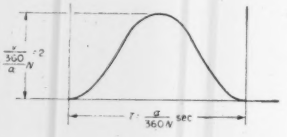
SINE CURVE ACCELERATION



$$\frac{a}{S\left(\frac{360}{\alpha}N\right)^2} = 2\pi \sin 2\pi\,\frac{t}{T};\ \frac{t}{T} = 0 \text{ to } 1$$

$C_b = C_f = 0;\ C_a = -\,C_d = 2\pi = 6.283$

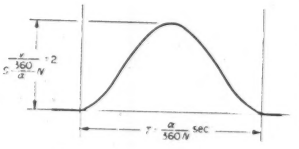
$$\frac{v_1}{S\left(\frac{360}{\alpha}N\right)} = 16\left(\frac{t}{T}\right)^2$$



$$\frac{v_2}{S\left(\frac{360}{\alpha}N\right)} = 16\left[\frac{t}{T} - \left(\frac{t}{T}\right)^2 - \frac{1}{8}\right]$$

$$\frac{v_3}{S\left(\frac{360}{\alpha}N\right)} = 16\left[\left(\frac{t}{T}\right)^2 - 2\,\frac{t}{T} + 1\right]$$

$C_v = 2$



$$\frac{v}{S\left(\frac{360}{\alpha}N\right)^2} = 1 - \cos 2\pi\,\frac{t}{T}$$

$C_v = 2$

$$\frac{s_1}{S} = \frac{16}{3}\left(\frac{t}{T}\right)^3$$

$$\frac{s_2}{S} = \frac{1}{6} - 2\left(\frac{t}{T}\right) + 8\left(\frac{t}{T}\right)^2 - 16\left(\frac{t}{T}\right)^3$$

$$\frac{s_3}{S} = -\,\frac{13}{3} + 16\left(\frac{t}{T}\right) - 16\left(\frac{t}{T}\right)^2 - \frac{16}{3}\left(\frac{t}{T}\right)^3$$

$$\frac{s}{S} = \frac{t}{T} - \frac{\sin 2\pi\,\frac{t}{T}}{2\pi}$$

$$\frac{\delta_v}{\delta_s}\,C_a = C_a\,\frac{4}{\pi m}\left[\sin 2\pi m\,\frac{t}{T}\left(\cos\frac{1}{2}\pi m - \cos\frac{3}{2}\pi m - \frac{1-\cos 2\pi m}{2}\right) - \cos 2\pi m\,\frac{t}{T}\times\left(\sin\frac{1}{2}\pi m - \sin\frac{3}{2}\pi m + \frac{\sin 2\pi m}{2}\right)\right]$$

$$\frac{t}{T} \geq 1$$

$$\frac{\delta_v}{\delta_s}\,C_a = C_a\,\frac{m}{m^2-1}\left[\sin 2\pi m\left(\frac{t}{T} - 1\right) - \sin 2\pi m\,\frac{t}{T}\right]$$

$$\frac{t}{T} \geq 1$$

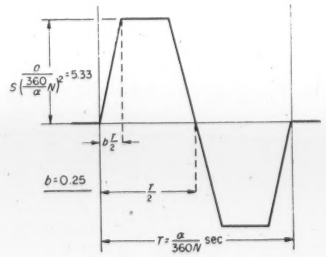
Table 2—Equations and Vibration Analysis for Trapezoid and Modified Trapezoid Acceleration Cams

Acceleration

TRAPEZOID ACCELERATION

$$\frac{a_1}{S\left(\frac{360}{\alpha}N\right)^2} = \frac{4}{1-b}\,\frac{2}{b}\,\frac{t}{T}$$

$$\frac{t}{T} = 0 \text{ to } \frac{b}{2}$$



$$\frac{a_2}{S\left(\frac{360}{\alpha}N\right)^2} = \frac{4}{1-b};\quad \frac{t}{T} = \frac{b}{2} \text{ to } \frac{1-b}{2}$$

$$\frac{a_3}{S\left(\frac{360}{\alpha}N\right)^2} = \frac{4}{1-b}\,\frac{1-2\frac{t}{T}}{b};\quad \frac{t}{T} = \frac{1-b}{2} \text{ to } \frac{1+b}{2}$$

$$\frac{a_4}{S\left(\frac{360}{\alpha}N\right)^2} = -\frac{4}{1-b};\quad \frac{t}{T} = \frac{1+b}{2} \text{ to } \frac{2-b}{2}$$

$$\frac{a_5}{S\left(\frac{360}{\alpha}N\right)^2} = -\frac{4}{1-b}\,\frac{2\left(1-\frac{t}{T}\right)}{b};\quad \frac{t}{T} = \frac{2-b}{2} \text{ to } 1$$

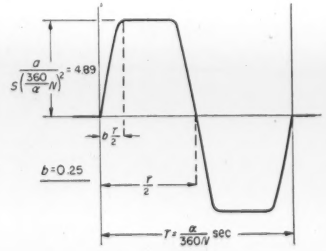
$$C_a = -C_d = \frac{4}{1-b}$$

b	0	0.15	0.25	0.35	0.50
C_a	4.00	4.71	5.33	6.15	8.00

MODIFIED TRAPEZOID ACCELERATION

$$\frac{a_1}{S\left(\frac{360}{\alpha}N\right)^2} = \frac{2\pi}{\frac{\pi}{2} - b(\pi-2)}\sin\frac{\pi}{b}\,\frac{t}{T}$$

$$\frac{t}{T} = 0 \text{ to } \frac{b}{2}$$



$$\frac{a_2}{S\left(\frac{360}{\alpha}N\right)^2} = \frac{2\pi}{\frac{\pi}{2} - b(\pi-2)}$$

$$\frac{t}{T} = \frac{b}{2} \text{ to } \frac{1-b}{2}$$

$$\frac{a_3}{S\left(\frac{360}{\alpha}N\right)^2} = \frac{2\pi}{\frac{\pi}{2} - b(\pi-2)}\sin\frac{\pi}{b}\left(\frac{t}{T} - \frac{1-2b}{2}\right)$$

$$\frac{t}{T} = \frac{1-b}{2} \text{ to } \frac{1+b}{2}$$

$$\frac{a_4}{S\left(\frac{360}{\alpha}N\right)^2} = -\frac{2\pi}{\frac{\pi}{2} - b(\pi-2)};\quad \frac{t}{T} = \frac{1+b}{2} \text{ to } \frac{2-b}{2}$$

$$\frac{a_5}{S\left(\frac{360}{\alpha}N\right)^2} = \frac{2\pi}{\frac{\pi}{2} - b(\pi-2)}\sin\frac{\pi}{b}\left(\frac{t}{T} - 1 + 2b\right)$$

$$\frac{t}{T} = \frac{2-b}{2} \text{ to } 1$$

$$C_a = -C_d = \frac{2\pi}{\frac{\pi}{2} - b(\pi-2)}$$

b	0	0.15	0.25	0.35	0.5
C_a	4.00	4.49	4.89	5.36	6.28

$$\frac{v_1}{S\left(\frac{360}{\alpha}N\right)} = \frac{4}{(1-b)b}\left(\frac{t}{T}\right)^2$$

$$\frac{v_1}{S\left(\frac{360}{\alpha}N\right)} = \frac{2\pi}{\frac{\pi}{2} - b(\pi-2)}\,\frac{b}{\pi}\left(1 - \cos\frac{\pi}{b}\,\frac{t}{T}\right)$$

Velocity

$$\frac{v_1}{S\left(\frac{360}{\alpha}N\right)} = \frac{4}{(1-b)b}\left(\frac{t}{T}\right)^2$$

$$\frac{v_2}{S\left(\frac{360}{\alpha}N\right)} = \frac{4}{1-b}\left(\frac{t}{T} - \frac{b}{4}\right)$$

$$\frac{v_3}{S\left(\frac{360}{\alpha}N\right)} = \frac{4}{(1-b)b}\left[\frac{t}{T} - \left(\frac{t}{T}\right)^2 - \frac{1-2b+2b^2}{4}\right]$$

$$\frac{v_4}{S\left(\frac{360}{\alpha}N\right)} = \frac{4}{1-b}\left(\frac{t}{T} - \frac{1+b}{2}\right)$$

$$\frac{v_5}{S\left(\frac{360}{\alpha}N\right)} = \frac{4}{(1-b)b}\left[\left(\frac{t}{T}\right)^2 - 2\left(\frac{t}{T}\right) + 1\right]$$

$C_v = 2$

$$\frac{v_1}{S\left(\frac{360}{\alpha}N\right)} = \frac{2\pi}{\frac{\pi}{2} - b(\pi-2)}\frac{b}{\pi}\left(1 - \cos\frac{\pi}{b}\frac{t}{T}\right)$$

$$\frac{v_2}{S\left(\frac{360}{\alpha}N\right)} = \frac{2\pi}{\frac{\pi}{2} - b(\pi-2)}\left(\frac{b}{\pi}\frac{2-\pi}{2} + \frac{t}{T}\right)$$

$$\frac{v_3}{S\left(\frac{360}{\alpha}N\right)} = \frac{2\pi}{\frac{\pi}{2} - b(\pi-2)}\left[\frac{2b + \pi(1-2b)}{2\pi} - \frac{b}{\pi}\cos\frac{\pi}{b}\left(\frac{t}{T} - \frac{1-2b}{2}\right)\right]$$

$$\frac{v_4}{S\left(\frac{360}{\alpha}N\right)} = \frac{2\pi}{\frac{\pi}{2} - b(\pi-2)}\left[\frac{2\pi - b(\pi-2)}{2\pi} - \frac{t}{T}\right]$$

$$\frac{v_5}{S\left(\frac{360}{\alpha}N\right)} = \frac{2\pi}{\frac{\pi}{2} - b(\pi-2)}\left[1 - \cos\frac{\pi}{b}\left(\frac{t}{T} - 1 + 2b\right)\right]$$

$C_v = 2$

Displacement

$$\frac{s_1}{S} = \frac{4}{3(1-b)b}\left(\frac{t}{T}\right)^3$$

$$\frac{s_2}{S} = \frac{1}{1-b}\left[\frac{b^2}{6} - b\left(\frac{t}{T}\right) + 2\left(\frac{t}{T}\right)^2\right]$$

$$\frac{s_3}{S} = \frac{1}{(1-b)b}\left[\frac{1-3b+3b^2}{6} - (1-2b+2b^2)\left(\frac{t}{T}\right) + 2\left(\frac{t}{T}\right)^2 - 4\left(\frac{t}{T}\right)^3\right]$$

$$\frac{s_4}{S} = \frac{1}{1-b}\left[\frac{-6-b^2}{6} + (4-b)\frac{t}{T} - 2\left(\frac{t}{T}\right)^2\right]$$

$$\frac{s_5}{S} = \frac{4}{(1-b)b}\left[\frac{-4/3+b-b^2}{4} + \frac{t}{T} - \left(\frac{t}{T}\right)^2 + \frac{1}{3}\left(\frac{t}{T}\right)^3\right]$$

$$\frac{s_1}{S} = C_a\frac{b}{\pi}\left(\frac{t}{T} - \frac{b}{\pi}\sin\frac{\pi}{b}\frac{t}{T}\right)$$

$$\frac{s_2}{S} = C_a\left[\frac{(\pi^2-8)b^2}{8\pi^2} + \frac{b(2-\pi)}{2\pi}\frac{t}{T} + \frac{1}{2}\left(\frac{t}{T}\right)^2\right]$$

$$\frac{s_3}{S} = C_a\left[\frac{\pi(2b-1)}{8\pi} + \frac{\pi - 2b(\pi-1)}{2\pi}\frac{t}{T} - \frac{b^2}{\pi^2}\sin\frac{\pi}{b}\left(\frac{t}{T} - \frac{1-2b}{2}\right)\right]$$

$$\frac{s_4}{S} = C_a\left[\frac{8b^2 - \pi^2b^2 - 2\pi^2}{8\pi^2} + \frac{2\pi - b(\pi-2)}{2\pi}\frac{t}{T} - \frac{1}{2}\left(\frac{t}{T}\right)^2\right]$$

$$\frac{s_5}{S} = C_a\left[\frac{1-2b}{4} + \frac{b}{\pi}\frac{t}{T} - \frac{b^2}{\pi^2}\sin\frac{\pi}{b}\left(\frac{t}{T} - 1 + 2b\right)\right]$$

Vibrations

$$\frac{t}{T} \geq 1$$

$$\frac{\delta_v}{\delta_s}C_a = C_a\frac{1}{b\pi m}\left[\sin 2\pi m\left(\frac{t}{T} - \frac{b}{2}\right) + \sin 2\pi m\left(\frac{t}{T} - \frac{1-b}{2}\right) - \sin 2\pi m\left(\frac{t}{T} - \frac{1+b}{2}\right) - \sin 2\pi m\left(\frac{t}{T} - \frac{2-b}{2}\right) + \sin 2\pi m\left(\frac{t}{T} - 1\right) - \sin 2\pi m\frac{t}{T}\right]$$

$$\frac{\delta_v}{\delta_s}C_a = C_a\frac{1}{(2bm)^2 - 1}\left\{\sin 2\pi m\frac{t}{T}\left[\sin b\pi m - \sin(1-b)\pi m - \sin(1+b)\pi m + \sin(2-b)\pi m - 2bm(1-\cos 2\pi m)\right] + \cos 2\pi m\frac{t}{T}\left[\cos b\pi m - \cos(1-b)\pi m - \cos(1+b)\pi m + \cos(2-b)\pi m - 2bm\sin 2\pi m\right]\right\}$$

The ratio δ_v/δ_s decreases with an increase of m.

$$v = \frac{S}{T} f_v(t)$$

or

$$\frac{v}{S\left(\frac{360}{\alpha} N\right)} = f_v(t) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (5)$$

The function $f_v(t)$ is also dimensionless and can be called a *coefficient of velocity*. It is also characteristic for each acceleration diagram. Knowledge of the velocity has limited value, since seldom is a certain magnitude of velocity required at some point of the movement. The maximum value of the velocity coefficient can be determined and it is designated as C_v.

The equation for the displacement can be written as:

$$s = S f_s(t)$$

or

$$\frac{s}{S} = f_s(t) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

The maximum value of $f_s(t)$ should be unity because the maximum displacement is equal to the stroke.

In the analysis of mechanisms other than cams, the equations often can be written in the same form as Equations 4 and 5, so their coefficients of accelera-

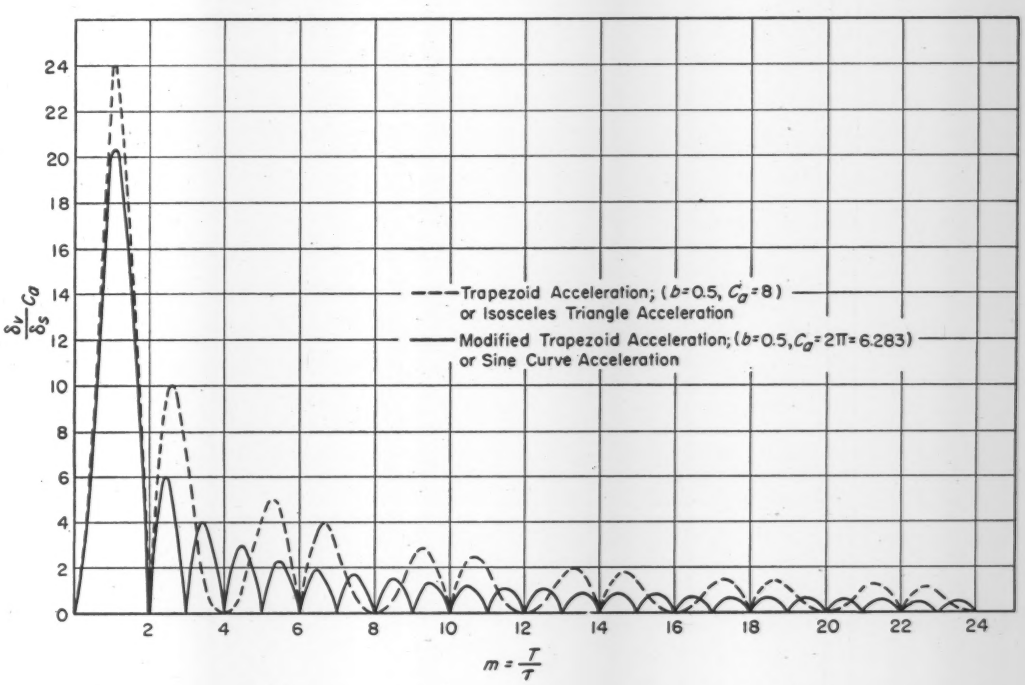


Fig. 3 — Comparison of ratios of dynamic to static stresses for trapezoid and modified trapezoid accelerations plotted as functions of the ratio of cam period to period of free vibration of the follower

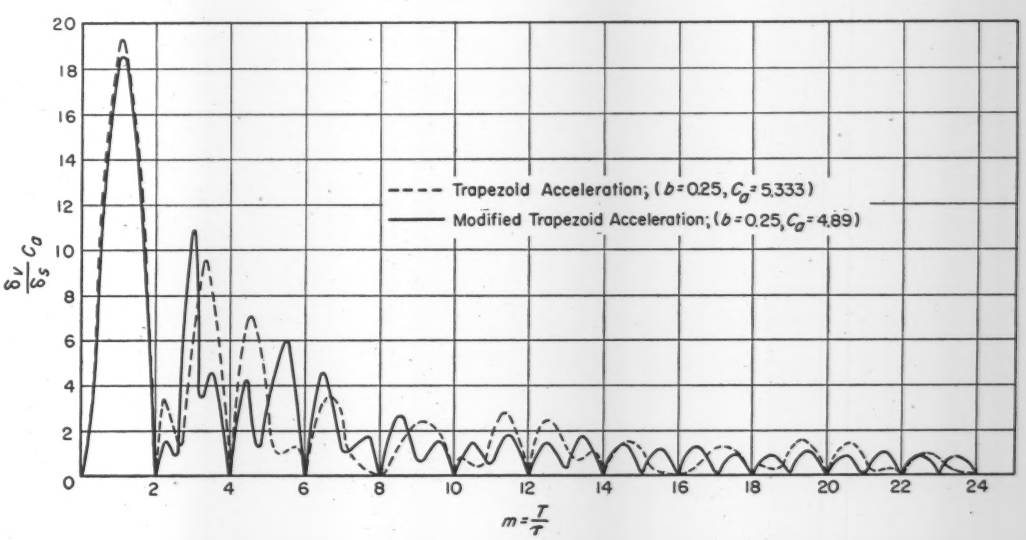


Fig. 4 — Comparison similar to *Fig.* 3 except for different duration of uniform acceleration with respect to the total period

tion and of velocity can be compared with the analyzed theoretical accelerations for cams. Then a decision can be made in the selection of a cam drive or a certain mechanism.

Displacement tables can be made for cutting master cams, and they can be used also for determining positions of a driven machine part during different moments of the stroke. From practical experience it was found that a table dividing the working period into 120 parts is sufficient for cutting even large cams. This number was found convenient because it is divisible by 2, 3, 4, 5, and 6. Therefore, the table with 120 divisions can be used for 60 divisions by reading every other line in the table, it can be used for 40 divisions by reading every third line, and so on. A smaller number of divisions is used for cutting small cams and also for reference by designers in determining positions of cam followers. Against each division of the working period, the displacement is tabulated as a fraction of the total stroke in the form s/S. Such a table thus can be used for any working period since it is divisible by 120 (or 60, 40, etc.), and for any stroke, by multiplying the figures in the table by the stroke S.

The analysis of acceleration diagrams is not complete without a checking of the actual stresses produced by vibrations created by variations of inertia forces. Vibrations produced during the period of application of inertia forces may be of interest to the designer, but the vibrations which continue after the removal of acting forces are even more important, because the next application of forces during the following stroke may increase them and cause really excessive stresses and deflections in the mechanism. Even if these vibrations are not visible to an observer, the product handled by the machine may be sufficiently disturbed by them. As a result, a lower efficiency and a greater wear of moving parts can be observed; the latter is usually manifested by the noise.

Table 3—Acceleration of External Genevas

Slots	Index Period (deg)	$c_b = -c_f$	$C_a = -C_d$
3	60	0.82	16.4
4	90	1.57	8.45
5	108	2.05	6.50
6	120	2.42	5.65
8	135	2.93	4.95
10	144	3.27	4.66
12	150	3.51	4.55
20	162	4.03	4.48

Table 4—Acceleration of Internal Genevas

Stations per rev of Driven Shaft	$c_b = -c_f = -C_d = C\alpha$	Indexing Period of Driving Shaft (deg)
3	22.67	300
4	14.14	270
5	11.18	252
6	9.67	240
8	8.13	225
10	7.35	216
12	6.87	210
20	6.02	198

The aim of the vibration analysis is to compare the effects of different types of acceleration. Sufficiently dependable results can be obtained by checking the vibrations created in a simple mechanism. To simplify the problem, the damping of vibrations is not considered. In high-speed automatic machines the period between two strokes is very short (quite often a small fraction of a second), and in actual practice an application of damping devices, except friction, may be too complicated, if not impossible. Again however, vibrations produced by any one of the analyzed movements will be affected by the presence of damping in a similar way.

The equations for acceleration diagrams can be written in the form:

$$a = C_a f(t),$$

where C_a represents the maximum acceleration when

$$S\left(\frac{360}{\alpha}N\right)^2 = 1$$

The value of C_a can represent the maximum inertia force in pounds if the acceleration is applied to a unit of mass. If this force is applied statically to a mechanism, it produces stresses, or deflections, which will be designated as δ_s.*

The deflections, or stresses, produced during vibrations, designated by δ_v, are compared with δ_s by the ratio δ_v/δ_s which shows how much the dynamic stresses are higher or lower than the static stresses produced by a static load equal to the maximum value of the inertia force. The static stresses are proportional to the value of the force represented by the maximum acceleration coefficient C_a which varies for different types of acceleration. To compare the stresses produced by different types of acceleration, it is necessary to multiply the ratio δ_v/δ_s by C_a.

It is assumed that the mechanism acted upon by the cam follower has the period of free vibration $= \tau$ sec. Therefore, mechanisms with the same ratio,

$$\frac{T}{\tau} = m$$

will perform in a similar way. Ratio m represents the number of free vibrations during the period of the stroke. The aim of the analysis is to find the influence of this ratio on the stresses expressed in the form

$$\frac{\delta_v}{\delta_s} C_a$$

as a function of m.

Vibrational stresses vary from plus to minus maximum during each period of τ sec. The designer is interested only in the maximum stresses; therefore, diagrams show for each value of m only the highest stresses produced during vibrations. The analysis covers only vibrations caused by accelerations which are presented by simple mathematical expressions. Accelerations of some mechanisms other than cams are too complicated for integration and for finding

* S. P. Timoshenko—*Vibration Problems in Engineering*, Van Nostrand Co., New York, 1937.

maximum values of $(\delta_v/\delta_s)C_a$ for different ratios m. In this case, for an approximate appraisal, the vibrations caused by such mechanisms can be compared with vibrations produced by accelerations whose diagrams approach the shape of the acceleration diagrams of these mechanisms.

For each analyzed acceleration diagram the following data are presented in TABLES 1 and 2:

Acceleration: diagram, equations, and values of acceleration coefficients.

Velocity: diagram, equations, and the maximum velocity coefficient.

Displacement: equations.

Vibration after the removal of force: equation and analysis of it, showing when the ratio $(\delta_v/\delta_s)C_a$ reaches its maximum and the magnitude of it; only in two cases of the most advantageous accelerations are the vibrational stresses presented on separate graphs.

UNIFORM ACCELERATION: In reference to TABLE 1 for this case, the appearance of high vibrational stresses is cyclic—the maximum stresses appear again and again when m changes by 2. The designer cannot guarantee to maintain the ratio T/τ constant because the speed of the machine may vary due to fluctuation of voltage when the machine is driven by an electric motor and due to changes in frictional resistance in the whole machine. When m is large, or τ is small, a slight variation of speed, which affects the time T of the stroke, may change the ratio m sufficiently to approach a peak of vibrational stresses.

This acceleration diagram can be used successfully only on slow-moving machines where inertia forces are low and vibrations can be sufficiently damped before the next stroke is performed.

It should be mentioned that during the acceleration period, the vibrational stresses are twice as high as the static stresses; during the deceleration period, the vibrational stresses vary between 2 δ_s and 3 δ_s depending on the value of m. As shown in TABLE 1, after the removal of inertia forces, the vibrational stresses can be between 0 and 4 δ_s.

COSINE CURVE ACCELERATION (HARMONIC): This acceleration, TABLE 1, represents a theoretical case of a ratchet drive operated by a Scotch yoke when the ratchet pawl engages the wheel without any clearance between the pawl and the tooth. The appearance of high vibration stresses is cyclic—the maximum stresses appear when m changes by 1. The performance of the machine is of the same nature as with uniform acceleration, except that vibrational stresses are somewhat lower by approximately 10/16.

Regular or external Geneva drives with five or more slots (stations per revolution of the driven shaft) have acceleration diagrams approaching the shape of the cosine curve as the number of slots increases. Acceleration coefficients of external geneva drives are given in TABLE 3.

TRIANGULAR ACCELERATION I: This type of acceleration, TABLE 1, creates conditions similar to the cosine curve acceleration, but the maximum vibrational stresses are higher. Internal Geneva drives used for intermittent motion have a similar diagram, *Fig.* 2, but with higher coefficients of acceleration as TABLE 4 shows.

Sometimes the statement is made that internal Geneva drives have low acceleration. This is true, but the reason for it is the long indexing period α.

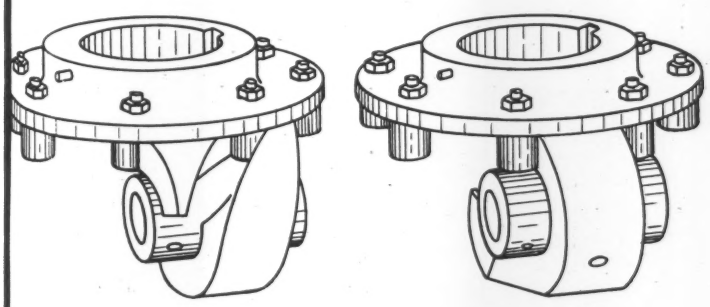


Fig. 5—Above—Conventional cam drive for intermittent motion

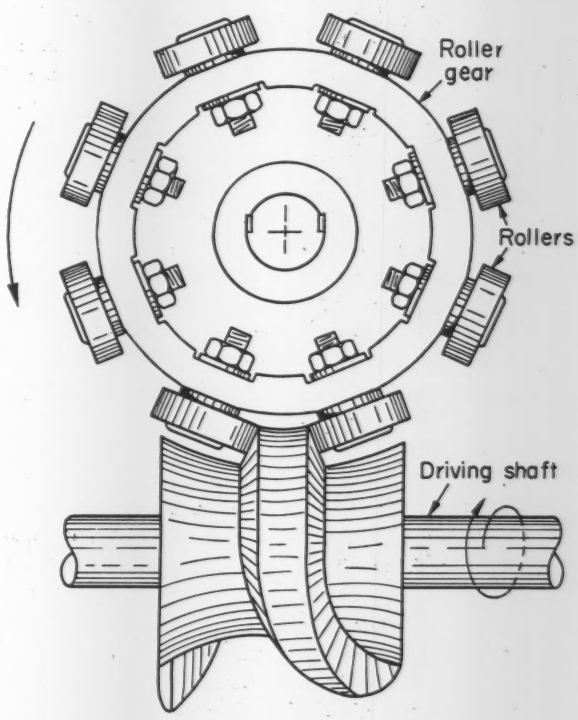


Fig. 6 — Right — Roller Gear cam drive for intermittent motion

As compared with cam movements with the same value of α, they are inferior due to the high coefficient of acceleration and the unfavorable acceleration diagram.

TRIANGULAR ACCELERATION II: Although the acceleration starts from zero and comes gradually to zero at the end of the stroke, nevertheless, the vibration stresses are higher than in any of the diagrams so far analyzed. The reason for this is in the abrupt change from maximum acceleration to maximum deceleration.

Regular or external Geneva drives with three and four slots (stations per revolution of the driven shaft) have acceleration diagrams approaching this triangular acceleration diagram. The change of the acceleration from plus maximum to minus maximum is fast but not abrupt, and the acceleration at the start of the movement and the deceleration at the end of the movement have a finite value, TABLE 3.

Quite a few automatic machines are not adaptable for higher speeds on account of the use of Geneva drives with three or four slots because of the type of acceleration diagram. The short working period was only a contributing factor to this failure.

A similar acceleration diagram is created by elliptical gears, especially in cases when the expression:

$$e = \sqrt{1 - \left(\frac{b}{a}\right)^2} \geq 0.5$$

where $2a$ is the major axis of the ellipse and $2b$ is the minor axis.

All acceleration diagrams presented in the foregoing have one common property—the acceleration changes abruptly once, twice, or three times during the stroke. The next group of diagrams has no abrupt changes.

ISOSCELES TRIANGLE ACCELERATION: It is evident that the ratio δ_v/δ_s decreases with an increase of m; therefore, the designer has a method available to decrease the magnitude of vibration stresses by decreasing the period τ of free vibrations. It can be done by making the moving parts lighter and stiffer.

SINE-CURVE ACCELERATION: This type, TABLE 1, is often termed the cycloidal. The ratio δ_v/δ_s decreases with an increase of $m = T/\tau$, or with a decrease of the period τ of free vibrations. It is evident that the last two diagrams are better than the ones which have abrupt variation of the acceleration. On the other hand, the coefficient of maximum acceleration is higher than with uniform acceleration: ± 6.283 for sine curve and ± 8 for isosceles triangle, while it is ± 4 for uniform acceleration.

TRAPEZOID ACCELERATIONS: To counteract this disadvantage, two groups of diagrams have been analyzed, TABLE 2. They represent modifications of the isosceles triangle and of the sine curve. In both cases uniform acceleration has been introduced in the middle of each half of the stroke. Thus, the isosceles triangle is transformed into a trapezoid, and the sine curve is changed into a diagram which will be called a modified trapezoid. It represents a trapezoid with straight sides replaced by quadrants of a sine curve.

On both diagrams the designer can select the length of time during which the acceleration changes from zero to maximum or vice versa. This period is designated by b, and is expressed as a fraction of half the time for the full stroke. When $b = 0$, both diagrams change to uniform acceleration. When $b = 0.5$, the trapezoid diagram becomes the isosceles triangle and the modified trapezoid becomes a sine curve.

Both trapezoid diagrams have good properties permitting the designer to decrease the vibration stresses after the stroke is completed. It can be done by lightening moving parts and/or by increasing the stiffness of them.

In *Figs.* 3 and 4 the value of $(\delta_v/\delta_s)C_a$ is plotted as a function of $m = T/\tau$; it shows a theoretical maximum of the stresses for $S(360N/\alpha)^2 = 1$ for certain values of m. *Fig.* 3 is made for $b = 0.5$ for comparison of stresses with sine curve and isosceles triangle accelerations. It shows that the sine curve is more advantageous. *Fig.* 4 is made for $b = 0.25$ and it indicates a slight advantage of the modified trapezoid over the trapezoid.

Generally speaking, the stresses during the stroke

Table 5—Displacement of Modified Trapezoid in terms of s/S

Division	b=0.25	b=0.5	Division	b=0.25	b=0.5
0	.000	.000	20	.500	.500
1	.00016	.00010	21	.550	.550
2	.00126	.00082	22	.599	.599
3	.00413	.00275	23	.646	.647
4	.0095	.0065	24	.691	.694
5	.0177	.0125	25	.732	.738
6	.0289	.0212	26	.771	.779
7	.0432	.0332	27	.807	.817
8	.0606	.0486	28	.839	.851
9	.0810	.0678	29	.869	.882
10	.1045	.0908	30	.8955	.9092
11	.131	.118	31	.9190	.9322
12	.161	.149	32	.9394	.9514
13	.193	.183	33	.9568	.9668
14	.229	.221	34	.9711	.9788
15	.268	.262	35	.9823	.9875
16	.309	.306	36	.9905	.9935
17	.354	.353	37	.99587	.99725
18	.401	.401	38	.99874	.99918
19	.450	.450	39	.99984	.99990
20	.500	.500	40	1.000	1.000

Table 6—Roller Gears with Few Stops in terms of s/S for $b = 0.25$

Stops Per Gear Rev	Rollers on Gear	Rollers Passed by Cam per Rev
2	6 or 8	3 or 4
3	6 or 9	2 or 3
4	8	2
5	10	2

Table 7—Accelerations for Equal Periods

b	C_a	C_d	C_a/C_d
0	4.0	4.0	1.0
0.15	4.37	4.12	1.06
0.25	4.68	4.22	1.11
0.35	5.06	4.33	1.17
0.5	5.81	4.52	1.29

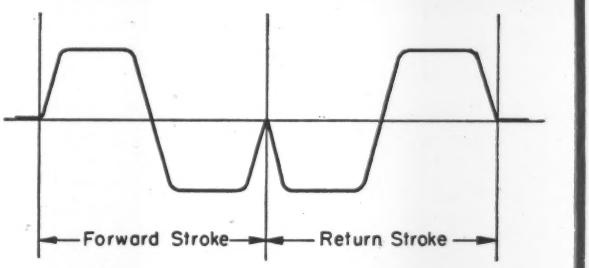
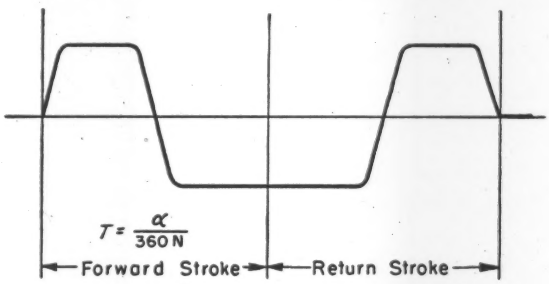


Fig. 7—Above—Modified trapezoid acceleration developed for single movement shown applied to forward and immediate return strokes. Acceleration need not return to zero between strokes as shown here

Fig. 8—Below — Modified trapezoid II, with uniform acceleration continuous through point marking division of forward and return strokes



or during the action of inertia forces should be smaller if the period τ of free vibrations is shorter than $bT/2$.

For equal maximum acceleration coefficient, the period b of the modified trapezoid is 37.6 per cent longer than the period b of the trapezoid. That fact gives an additional advantage to the modified trapezoid. There is a practical consideration in favor of a modified trapezoid with b smaller than 0.5: the displacement at both ends of the stroke is very small; it is exceptionally small with the isosceles triangle due to a smaller rate of increase of the acceleration; and with the trapezoid this rate of increase of the acceleration is smaller than for the modified trapezoid.

The insufficient precision of machine tools and the necessity of cutting a master cam in steps, with hand filing between them, may distort the shape of the cam, so that actually a theoretical acceleration diagram will not be exactly produced by the cam. Therefore, $b = 0.25$ and the modified trapezoid diagram can be considered more practical.

To approach theoretical dimensions of cams during reproduction of them from a master cam, cut on a jig borer, a special cam cutting device was developed by Ferguson Machine and Tool Co. This equipment has minimum stresses between the master cam and the cutting tool to decrease the deflections in parts connecting them.

In TABLE 5 are given the displacements of the modified trapezoid with $b = 0.25$ and with $b = 0.5$ (sine curve). It uses 40 divisions for the working period of the cam, so that it is suitable for appraisal of positions of the cam followers during the rotation of the cam. Another purpose of the table is to demonstrate the size of displacements at both ends of the stroke.

The use of the modified trapezoid with $b = 0.25$ on flat and face cams, cut with properly designed cam cutting machines, improved many automatic machines at Universal Match Corp. but the greatest help for designers was observed in the application of the movement with this type acceleration to a device for producing intermittent motion.

As pointed out in earlier discussion of cosine and triangular diagrams of acceleration, ratchet drives and Geneva drives have characteristics undesirable for high-speed operations. Also, these drives do not provide by themselves a sufficiently precise locking of the driven shaft after each stroke. Therefore, a drive was designed for intermittent motion utilizing a barrel cam. Special machine tools were built to cut barrel cams producing modified trapezoid acceleration. This mechanism was named Ferguson Roller Gear Drive, and over a period of twenty years has been in use in high-speed automatic machines of different types and in machines requiring high precision of locked positions of the driven shaft after each stroke.

Ferguson Roller Gear Drive: A cam drive for intermittent motion shown on *Fig.* 5 is widely used, but it has a few inherent defects:

1. If cylindrical rollers are used, it is difficult to arrange and maintain high precision of locking during the dwell
2. If conical rollers are used, installation difficulty arises in maintaining more or less equal locking between pairs of rollers; the replacement of rollers requires an additional adjustment of the drive
3. Cutting is difficult because corrections must be made for different positions of rollers in respect to the plane passing through the axis of the cam and parallel to the axis of the driven wheel.

A Roller Gear Drive, shown in *Fig.* 6, has cylindrical rollers located radially. A slight change of the position of the rollers along the radii does not affect the work because the rollers are moved along the axis parallel to the side of a tapered rib. The presence of the tapered rib permits proper loading of rollers which is accomplished by bringing the driving and driven shafts closer. The use of ball bearings as rollers is advantageous because rollers of high precision are easily obtained and they permit preloading because of a certain inherent flexibility. They also allow building the drive with no backlash and with a precision of ± 0.001 inch.

The Roller Gear Drive is similar to a worm gear driven by a worm with a varying helix angle. The specific properties of a cam drive allow the Roller Gear Drive to have decided advantages over other mechanisms:

1. The indexing period may range from less than 90 up to 360 deg. Shorter indexing periods require larger cams; they can be used when there are no limitations in space on the machine and also when the speed is not high so that the inertia forces do not become too great

2. The shape of the cam rib can be made to produce any desired acceleration diagram
3. The number of stops per revolution of the gear can be from two on up.

Gears which should make six or more stops per revolution have the number of rollers equal to the number of stops—only one roller is passed during one revolution of the cam. These drives have the best proportions between the gear and the cam. If the number of stops is between two and five, then the gears should have more rollers than the number of stops, as shown in TABLE 6.

The necessity of passing more than one roller per stroke increases the size of the cam; therefore, the designer should by all means consider changing the design of the machine to permit the use of six or more stops per revolution of the gear.

When the number of stops per revolution of the gear is large, it is more practical to introduce gearing between the Roller Gear and the shaft which is to be moved intermittently. It is possible to use spur or herringbone gears for this purpose; for a very large number of stops a Cone Drive can be considered.

The building of Roller Gears with many rollers is possible, but the radius of the Roller Gear becomes too large, thus increasing the torque to overcome at high speed the inertia of the gear itself.

One of the most interesting applications of Roller Gear Drives is for multicolor printing presses printing a paper web. The feeding of the web is accomplished by a drum with the web wrapped on approximately 180 degrees of it, with clamps if necessary. Movements of the feeding drum must be precise to maintain register of colors, since the web advances many times between the first and last colors. In this case, a possible increase of the working period to the maximum, and the use of a quiet movement with the most advantageous acceleration, decrease the stretching of the web and improve the register considerably.

Another outstanding application of the Roller Gear Drive has been for driving dial feeds requiring a positive locking of the dial with high precision. The Roller Gear is locked at the same instant it stops moving, so there is no time lost for the locking operation.

Dwell-Rise-Reutrn-Dwell Movement: On the basis of the analysis of simple movements between two dwell periods, it can be accepted that the acceleration should not have any abrupt variations. A modified trapezoid acceleration as developed for a single movement should be adjusted. If it is applied without this adjustment, the acceleration diagram will be as presented in *Fig.* 7. The names of the strokes, forward and return, are used only to describe the fact that the movements are in opposite directions.

Near the point where the movement is reversed, the force created by the deceleration drops from maximum to zero and immediately increases again to the maximum value. The reason for this is that the force created by the acceleration during the return stroke acts in the same direction as the force produced by the deceleration of the forward stroke.

Table 8—Displacement of Modified Trapezoid II

Division	Forward	Return	Division	Forward	Return
0	.000	.000	20	.479	.521
1	.00015	.00132	21	.527	.569
2	.0012	.0053	22	.574	.615
3	.0040	.0119	23	.619	.661
4	.0091	.0211	24	.663	.703
5	.0169	.0329	25	.704	.743
6	.0277	.0474	26	.742	.781
7	.0414	.0646	27	.777	.815
8	.0581	.0843	28	.810	.846
9	.0776	.1067	29	.841	.874
10	.100	.132	30	.868	.900
11	.126	.159	31	.8933	.9224
12	.154	.190	32	.9157	.9419
13	.185	.223	33	.9354	.9586
14	.219	.258	34	.9526	.9723
15	.257	.296	35	.9671	.9831
16	.297	.337	36	.9789	.9909
17	.339	.381	37	.9881	.9960
18	.385	.426	38	.9947	.9988
19	.431	.473	39	.99868	.99985
20	.479	.521	40	1.000	1.000

There is no necessity to have this variation of inertia force at the reversal of the movement. *Fig.* 8 presents a diagram without this defect. It may be called the modified trapezoid II diagram.

The simple case of the double movement is when the working periods are equal. Then it is practical to have the same period b for both strokes and equal periods for the acceleration and the deceleration.

In the following discussion only the forward stroke is considered, since the diagram for the return stroke is a mirror image of it. The expression for acceleration of the return stroke is the same as the expression for deceleration of the forward stroke.

During the forward stroke with equal periods for the acceleration and the deceleration, the acceleration should be higher than the deceleration because the latter has only one period when the deceleration changes between zero and maximum. TABLE 7 shows the values of maximum acceleration and deceleration and the ratio between them for different values of b.

With $b = 0.25$, which is used in practice, the acceleration is only 11 per cent higher than the deceleration; but the coefficient of acceleration is only 4.68—while in the case of a simple movement (a stroke between two dwell periods) the same coefficient for the same conditions is 4.89. TABLE 8 gives the displacement when $b = 0.25$ for forty divisions of the working period for this type of movement, for the forward and return stroke. The latter, being a mirror image, is written by reversing the numbers of divisions of the working period and obtaining the displacement by subtracting the displacement for the forward stroke from 1.

The cases when the working periods of two strokes are not equal are more complicated. There appears the difference in magnitude of the deceleration of the forward stroke and the acceleration of the return stroke, so that there is a discontinuity in the acceleration diagram at the point of reversal of the direction of movement. If this discontinuity cannot be eliminated, at least it should be decreased.

The adjustment of this discontinuity by a change

of b cannot be effective because the working period α enters into the expression for the acceleration in the second power. Therefore, there is no valid reason to have different values of b, as it can be effective only when the difference between the working periods of two strokes is very small, and in such cases it may be possible to equalize the working periods.

A more effective method for the elimination of discontinuity in the acceleration diagram is to change the ratio between the acceleration and the deceleration periods of each stroke. Therefore, this ratio will be introduced into the equations for acceleration, velocity, and displacement. Let ϕ = (period for deceleration)/(period for acceleration), and let b remain constant.

The equations in general form are quite complicated; therefore, some constant terms involving ϕ and b are replaced by symbols, as follows:

$$\frac{A}{D} = M = \frac{\pi\phi(1-b)+2b}{\pi(1-2b)+4b} \quad \ldots\ldots\ldots\ldots\ldots\ldots (7)$$

where A = maximum acceleration and D = maximum deceleration.

$$H = \frac{2\pi^2}{\pi^2\phi(1-b)(1+\phi+b\phi)+2\pi b[1+2b\phi(1-\phi)]+8b^2\phi^2} \quad \ldots\ldots\ldots (8)$$

The expressions for coefficients of maximum acceleration and deceleration are:

$$C_a = \frac{A}{S\left(\frac{360}{\alpha}N\right)^2} = MH(1+\phi)^2 \quad \ldots\ldots\ldots\ldots (9)$$

$$C_d = \frac{D}{S\left(\frac{360}{\alpha}N\right)^2} = H(1+\phi)^2 \quad \ldots\ldots\ldots\ldots (10)$$

If for some reason the designer desires to find that value of ϕ which makes the maximum acceleration equal to the maximum deceleration, then $M = 1$. For this condition,

$$\phi = \frac{\pi(1-2b)+2b}{\pi(1-b)}$$

Values of ϕ for different values of b are as follows:

b	0	0.15	0.25	0.35	0.5
ϕ	1.0	0.936	0.879	0.804	0.637

There are several ways to write the equations: one of them is to use one variable t/T, which varies from 0 to 1; and other ways are to select arbitrary variables to simplify expressions. The latter method is used, and separate variables are selected for each section of the acceleration diagram, as shown in TABLE 9.

The preparation of displacement tables for each particular case with different values of ϕ is complicated; therefore, the following process can be used economically only when many cams with the same characteristics are required.

Two possible conditions may be encountered:

1. It may be desirable to have a high deceleration during the forward stroke—for instance, when the cam operates a punch which meets a resistance at the very end of the first stroke and the punch should be withdrawn as quickly as possible—to shorten the period of interference with the material handled by the machine. The working periods of both strokes can be made the same
2. When the strokes cannot have equal working periods.

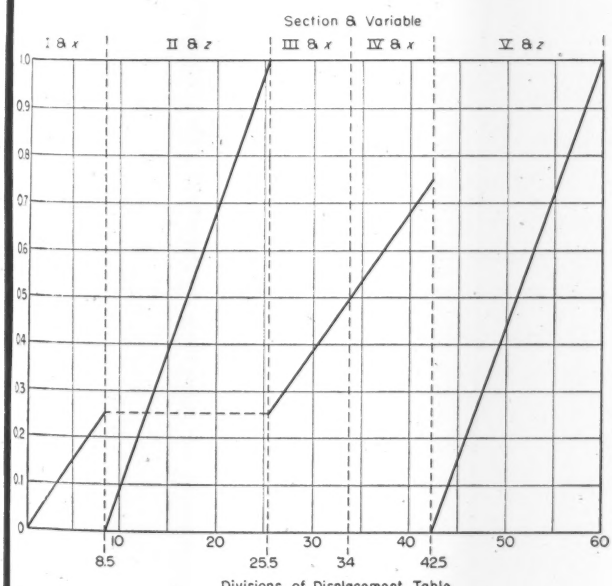
In the first case, the selection of ϕ can be done freely. It can be selected arbitrarily and ϕ should be less than 1. By introducing the selected values of ϕ and b into the expression designated M, the ratio between the acceleration and the deceleration can be found.

In the second case, many ways to solve the problem can be used. Here is an example of how the problem can be handled. The faster stroke is designed for $\phi = 1$, for which tables are available, and the slower stroke is adjusted for a certain value of ϕ greater or less than 1 to decrease or to eliminate the discontinuity of the acceleration diagram at the point of reversal of the direction of movement.

Suppose the faster stroke is the one which is designated as a forward stroke:

Let $b = 0.25$ and $\phi = 1$. The deceleration of this faster stroke is designated as D_f, and it can be found from Equation 10:

Fig. 9—Graphical method for determining values of variables x and z when number of divisions per section is not an integer



Section I—Increment=0.25/8.5=0.029412.

Section II—Increment=1/17, but minimum value of z, for division 9,=1/34 and the maximum value, for division 25,=33/34.

Section III—Increment=0.25/8.5=0.029412. Smallest value of x, for division 26,=0.25+(0.029412/2)=0.264706.

Section IV—Increment=0.25/8.5=0.029412. Highest value of x, for division 42,=0.75−(0.029412/2)=0.735294.

Section V—Increment=1/17.5=0.057142. Smallest value of z, for division 43,=0.057142/2=0.028571.

$$D_f = S\left(\frac{360}{\alpha_f}N\right)^2 H(1+\phi)^2$$

$$= S\left(\frac{360}{\alpha_f}N\right)^2 \frac{2\pi^2(4)}{\pi^2(0.75)(2.25) + 0.5\pi + 0.5}$$

$$= S\left(\frac{360}{\alpha_f}N\right)^2 (4.22) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

where $4.22 = C_d$, a value also available from TABLE 7.

The acceleration of the slow stroke (the return) should be approximately equal to D_f. It is designated as A_s and it is presented by the same Equation 10. However, the working period α_s is different than the period α_f for the fast stroke, and the ratio of ϕ is retained. Then:

$$A_s = D_f$$

$$= S\left(\frac{360}{\alpha_s}N\right)^2 \frac{2\pi(1+\phi)^2}{\pi^2\phi(1-b)(1+\phi+b\phi) + 2\pi b[1+2b\phi(1-\phi)] + 8b^2\phi^2} \quad \ldots\ldots\ldots\ldots (12)$$

In this case b is selected either equal to b of the faster stroke or, better, smaller than it—approximately in the ratio α_f/α_s—so the time for the change of the acceleration from zero to maximum would be approximately the same. From Equation 12 it is possible to derive the value of ϕ; it should be positive and <1. After that, the value of ϕ should be adjusted.

Usually there are other forces besides the inertia force acting on a part operated by the cam. For instance, the friction and the work to be done at the end of the forward stroke create a force which acts in the direction opposite to the inertia of the part during the deceleration period of the first (fast) stroke, and the frictional force acts in the same direction as the inertia force during the acceleration period of the second (return, or in this case, slow) stroke.

Therefore, the sum of the forces during the deceleration period of the fast stroke is less than the inertia force calculated for D_f in Equation 11, while the sum of the forces during the acceleration period of the slow stroke is greater than the inertia force only. This condition means that the ratio ϕ can be adjusted upward to decrease the acceleration of the second (slow) stroke.

In practical engineering work, the designer must guess some of the forces which will be encountered during the performance of a machine. The idea is to make the adjustment of ϕ for the return stroke in the right direction, while the size of the adjustment depends on the intuition of the designer and his appraisal of forces other than inertia forces.

Another reason for the adjustment of ϕ is to make the calculation of displacement tables easier. The process of this adjustment and the rules for making the tables for displacement are shown in the following example: Suppose, by selection, $b = 0.25$; ϕ is found to be 0.81, and the tables are made for 60 divisions.

Then Sections IV and V will occupy $60\phi/(1+\phi) = 60(0.81)/1.81 = 26.8$ divisions, and Sections I, II, and III will occupy $60/(1+\phi) = 60/1.81 = 33.2$ divisions. To allow for an increase of ϕ, select, for Sections IV and V, 28 divisions and, for Sections I, II, and III, 32 divisions.

Section I will occupy $32b = 8$ divisions on the table. The variable x changes from 0 to 0.25, so that an increase of x per division is $0.25/8 = 1/32$. Then the displacement is calculated for $x = 0$, $1/32$, $1/16$, $3/32$, $1/8$, etc.

Section II will occupy $32(1-2b) = 32(0.5) = 16$ divisions. The variable z changes from 0 to 1, so that the variable z increases $1/16$ per division. The displacements are calculated for $z = 0$, $1/16$, $1/8$, $3/16$, $1/4$, etc. When $z = 0$, the displacement should be equal to the displacement calculated for Section I when $x = 0.25$.

Section III will occupy 8 divisions and the increments of $x = 1/32$, the same as in Section I except that x varies from $1/4$ to $1/2$.

Section IV will occupy $28(b) = 7$ divisions. The variable x changes from 0.5 to 0.75, and the increase of x per division is $0.25/7 = 1/28$; or the displacements are calculated for $x = 1/2$, 15/28, 4/7, 17/28, 9/14, etc.

Section V will occupy $28(1-b) = 21$ divisions. Therefore, the variable z which changes from 0 to 1 will increase by increments equal to 1/21 per division.

It is better to select the distribution of periods of acceleration and deceleration in such a way that each section occupies a full number of divisions. In this case the displacements calculated for the end of one section and the beginning of the next are the same, so the designer is assured of the correctness of his calculations.

There are no particular objections to a distribution

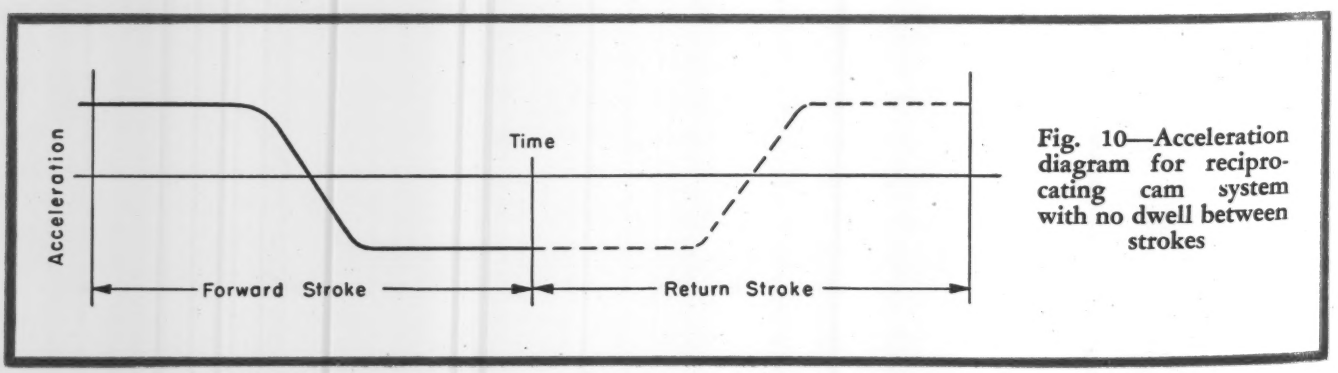
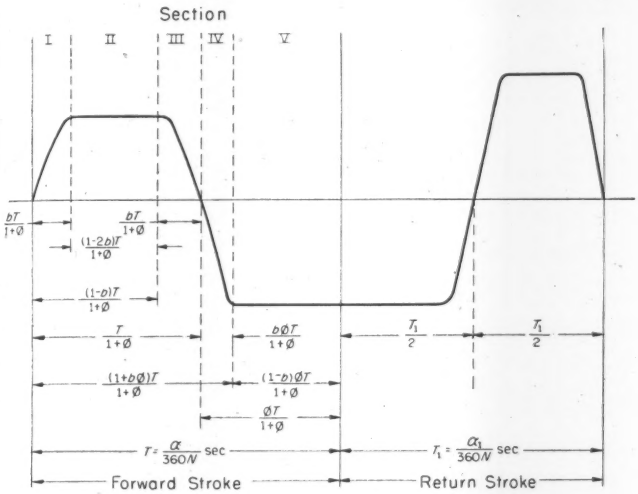


Fig. 10—Acceleration diagram for reciprocating cam system with no dwell between strokes

Table 9—Equations for Modified Trapezoid II Acceleration Cam



ACCELERATION

— I —

$$\frac{a_1}{S\left(\frac{360}{\alpha}N\right)^2} = MH(1+\phi)^2 \sin 2\pi x;\ x = 0 \text{ to } 0.25$$

— II —

$$\frac{a_2}{S\left(\frac{360}{\alpha}N\right)^2} = MH(1+\phi)^2;\ z = 0 \text{ to } 1$$

— III —

$$\frac{a_3}{S\left(\frac{360}{\alpha}N\right)^2} = MH(1+\phi)^2 \sin 2\pi x;\ x = 0.25 \text{ to } 0.5$$

— IV —

$$\frac{a_4}{S\left(\frac{360}{\alpha}N\right)^2} = H(1+\phi)^2 \sin 2\pi x;\ x = 0.5 \text{ to } 0.75$$

— V —

$$\frac{a_5}{S\left(\frac{360}{\alpha}N\right)^2} = -H(1+\phi)^2;\ z = 0 \text{ to } 1$$

VELOCITY

— I —

$$\frac{v_1}{S\left(\frac{360}{\alpha}N\right)} = MH(1+\phi)\frac{2b}{\pi}(1-\cos 2\pi x)$$

— II —

$$\frac{v_2}{S\left(\frac{360}{\alpha}N\right)} = MH(1+\phi)\left[\frac{2b}{\pi} + (1-2b)z\right]$$

— III —

$$\frac{v_3}{S\left(\frac{360}{\alpha}N\right)} = MH(1+\phi) \times \left[1-2b+\frac{2b}{\pi}(1-\cos 2\pi x)\right]$$

— IV —

$$\frac{v_4}{S\left(\frac{360}{\alpha}N\right)} = H(1+\phi) \times \frac{\pi\phi(1-b)+2b(1-\phi)-2b\phi\cos 2\pi x}{\pi}$$

— V —

$$\frac{v_5}{S\left(\frac{360}{\alpha}N\right)} = H(1+\phi)\,\phi\,(1-b)(1-z)$$

DISPLACEMENT

— I —

$$\frac{s_1}{S} = MH\frac{8b^2}{\pi}\left(x - \frac{\sin 2\pi x}{2\pi}\right)$$

— II —

$$\frac{s_2}{S} = MH\left[\frac{2b^2(\pi-2)}{\pi^2} + (1-2b)\left(2bz + \frac{1-2b}{2}z^2\right)\right]$$

— III —

$$\frac{s_3}{S} = MH\left\{\frac{\pi(8b^2-6b+1)+4b(1-2b)}{2\pi} + \frac{4b}{\pi}[\pi(1-2b)+2b]x - \frac{4b^2}{\pi^2}\sin 2\pi x\right\}$$

— IV —

$$\frac{s_4}{S} = H\left\{\frac{\pi\phi(1-b)(1-4b\phi)+2b[1-2b\phi(1-\phi)]}{2} + \frac{4b\phi[\pi\phi(1-b)+2b(1-\phi)]}{\pi}x - \frac{4b^2\phi^2}{\pi^2}\sin 2\pi x\right\}$$

— V —

$$\frac{s_5}{S} = H\left\{\frac{\pi\phi(1-b)(1+2b\phi)+2b+4b^2\phi(1-\phi)}{2\pi} + \frac{4b^2\phi^2}{\pi^2} + \phi^2(1-b)^2\left(z - \frac{z^2}{2}\right)\right\}$$

ALTERNATE VARIABLES

If for any reason it is desirable to have only one variable, t/T, which varies from 0 to 1, then the arbitrary variables can be replaced by the following expressions:

— I —

$$x = \frac{1+\phi}{2b}\frac{t}{T};\ \frac{t}{T} = 0 \text{ to } \frac{b}{1+\phi}$$

— II —

$$z = \frac{(1+\phi)}{1-2b}\frac{t}{T} - \frac{b}{1-2b};\ \frac{t}{T} = \frac{b}{1+\phi} \text{ to } \frac{1-b}{1+\phi}$$

— III —

$$x = \frac{1+\phi}{4b}\frac{t}{T} - \frac{1-2b}{4b};\ \frac{t}{T} = \frac{1-b}{1+\phi} \text{ to } \frac{1}{1+\phi}$$

— IV —

$$x = \frac{1+\phi}{4b\phi}\frac{t}{T} - \frac{1-2b\phi}{4b\phi};\ \frac{t}{T} = \frac{1}{1+\phi} \text{ to } \frac{1+b\phi}{1+\phi}$$

— V —

$$z = \frac{1+\phi}{\phi(1-b)}\frac{t}{T} - \frac{1+b\phi}{\phi(1-b)}\cdot\frac{t}{T} = \frac{1+b\phi}{1+\phi} \text{ to } 1$$

Note: Since most trigonometric tables are for angles expressed in degrees, $2\pi x$, after the sine or cosine should be replaced by 360 x in all equations, especially displacement.

of divisions between sections so that the number of divisions per section is not a full number. How the variables can be calculated graphically for all divisions of the table in such a case is shown in the chart of *Fig.* 9.

The value of the variables for each division should be calculated to the fourth or fifth decimal place; trigonometric tables with at least five decimal places should be used. The procedure of calculation of displacement tables appears to be complicated and long. But if the movement to be produced can be a limiting factor in speeding up standard machines, the time spent would be justified provided the cutting of cams is done properly and precisely.

Rise-Return-Rise Movement: Reciprocating movements without any dwell periods can be produced by cams with an acceleration diagram shown on *Fig.* 10. But cams cannot compete with a crank or eccentric movement—in simplicity, economy, and absence of the extra load caused by springs.

Maximum acceleration of the crank with the coefficient $C_a = -C_d = \pi^2/2 = 4.935$ is only slightly higher than the coefficient of the diagram shown in *Fig.* 10. The crank drive should be used wherever possible instead of cams described in the previous sections. Very often a crank can be incorporated by an increase of the stroke. The additional movement outside other parts of the machine can be equivalent to a dwell. During long practice the author replaced eccentric movement by a reciprocating cam movement with one dwell only in one case of punches on printing presses. The advantage of the cam movement was in the possibility to use cams with a 5/16-inch stroke instead of the 1¼-inch stroke required by the eccentric. Thus, wear of precision guides and the weight of moving parts were decreased.

Cams can be rightfully considered as a universally useful mechanism. They have decided advantages over all other mechanisms where a stroke starts from a dwell and ends at a dwell, especially for intermittent motion.

Putting Out Aircraft Fires

WHEN a modern aircraft ignites, the saying goes, it isn't so much a fire as it is a slow-burning explosion. New water-foam crash fire trucks developed by Air Force engineers will stand up to these hot fires, can operate in extremes of weather and temperature, and can actually douse the fire before old-style trucks can even get to the scene.

Having a capacity of 600 gallons of water-foam, the new type 0-10 can maintain a speed of 70 mph, and can hit 60 mph within 61 seconds from a fully loaded standing start. With a run of two miles to the fire, this means that the 0-10 will have 300 gallons of water-foam on the fire in 3.3 minutes after the alert, or before older types can even start pumping. Working at peak rate, its pumps can empty the 600-gallon capacity tank in less than two minutes.

This high acceleration was gained by the use of aluminum bodies, thus lightening total weight of the truck, and the provision of engines having roughly twice the horsepower of cargo trucks of similar size. The truck body and cab are integral, with operating personnel and all equipment enclosed in insulated, heated and ventilated compartments, except for remotely controlled nozzles and other components which must remain exposed.

Operating successfully in temperatures from −65 to +130 F, the 0-10 is fully insulated with a winterized body built up of an inside and outside layer of 21-gage aluminum with two inches of insulating material between. Basic heating system consists of a central coolant heater supplying 75,000 Btu per hour. Heated coolant is pumped through the vehicle engine oil pan and block, defrosting heaters, finned tubing in the various compartments, and a heat exchanger for heating water in the tank and piping.

A remotely controlled 2½ inch turret nozzle, of 200 gallons per minute capacity is installed on the cab roof. Both the truck driver and equipment operator have "joy-stick" controls to move this nozzle horizontally and vertically. Manual override of the remote controls is possible. This nozzle can dispense mechanical fog, fog-foam, water fog or a solid water stream. Three bumper type fog-foam nozzles are mounted at the front of the 0-10, two feet from the ground. These ground-sweep fog nozzles may be rotated 15 degrees vertically through remote controls. In addition to this automatic eaquipment, two foam handlines on automatic reels are included, as well as two under-truck nozzles to keep flames clear of the truck bottom.

"Research is one of the keys to progress. . . . We must use it, continuously and well, unless we are willing to see our economy and our society slow down and ultimately start sliding backwards"—LELAND I. DOAN, *president, Dow Chemical Co.*

Fig. 1—Ductile-iron castings for a blower housing and for a gear wheel

Designing with DUCTILE IRON

An up-to-the-minute survey of the characteristics of ductile iron with pertinent information on important design considerations

By John L. Gohsen
Development Metallurgist
American Brake Shoe Co.
New York

PROPERTIES of ductile iron and endless applications have already been described or suggested in print. Our foundry experience indicates that ductile iron has a bright future, but this article will deal in terms of the present only, especially with regard to those considerations that affect design.

An expanding development program has produced many excellent applications for ductile iron, *Fig.* 1, and research personnel continue the investigation of other possibilities. Construction is nearing completion on a new plant which will be devoted exclusively to production of ductile-iron castings. Here it is expected that a number of problems in casting and handling ductile iron will be solved through additional experience. The new plant at Medina, N. Y., will have 75,000 square feet of floor space and will produce ductile iron castings for the Air Force J-65 Sapphire Jet Engine. Present production is being

handled at a plant in Rochester, N. Y., and another foundry producing ductile iron is located in Mahwah, N. J. General foundry experience, as accumulated by ourselves and other producers of ductile iron, will provide the basis for much of the progress anticipated in the next five years.

At present our foundries are producing three grades of ductile iron commercially (under our tradename Ductalloy). Two grades are those for which tentative specifications have been drafted by ASTM —specifications based on physical properties rather than chemical analysis. The third is an austenitic grade with characteristics suiting certain aircraft applications. Properties of the three grades are as follows:

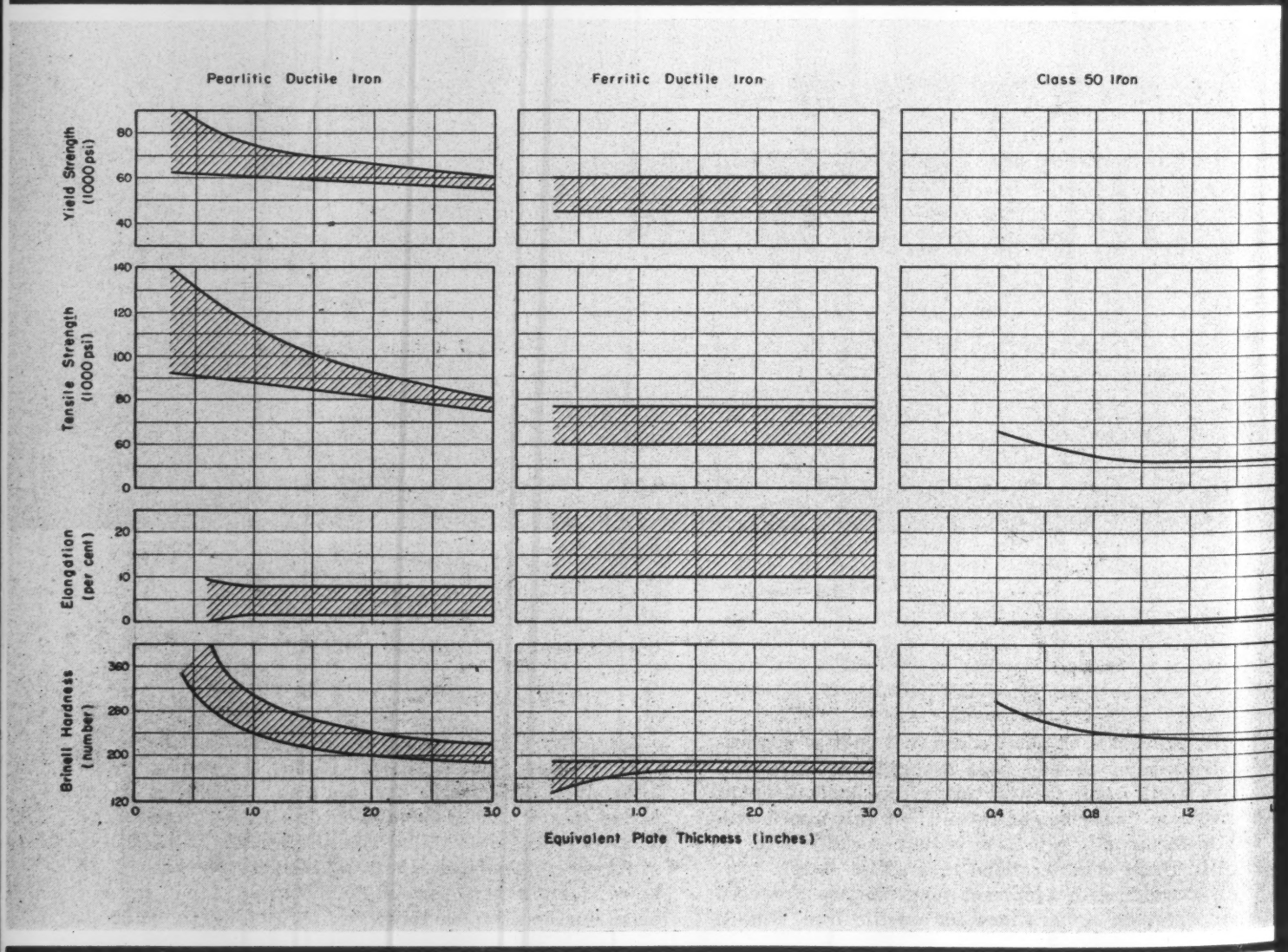
	Pearlitic (80-60-3)	Ferritic (60-45-10)	Austenitic (50-25-20)
Tensile strength, min, psi....	80,000	60,000	50,000
Yield strength, min, psi.....	60,000	45,000	25,000
Elongation, in 2 in. min, %..	3	10	20

From *Fig.* 2 the effect of section thickness on properties is indicated generally.

Material Cost: The cost of material is practically the same for a ladle full of ductile iron or of gray iron. The low sulphur content (0.02 per cent maximum) of ductile iron, however, entails some extra care which increases processing costs. Sulphur content is reduced by careful selection of raw materials, slag treatment in ladles, or basic linings in cupolas. Chromium (normally occurring as a tramp element) can increase the chilling tendencies of the iron, make heat treatment difficult, or reduce ductility, and special care is required to prevent inclusion of harmful amounts. Other impurities such as tin, lead, titanium, tellurium, etc., may prevent the formation of nodular graphite, *Fig.* 3.

Extra processing, therefore, brings the cost of ductile iron above that of gray cast iron, at least temporarily. Future processing experience and the handling of greater tonnages promise economies that may lower its price to the level of high-strength cast iron.

Cope Surfaces and Thin Sections: Among the troubles that formerly plagued our foundry were defects in the cope surface and chilling of thin sections. The top surface (cope) with respect to the mold



sometimes contained pits similar to those caused by slag particles, and thin sections (under ½-inch) had a tendency to chill, requiring extra heat treatment. The last few months has seen considerable progress in circumventing these troubles, however, and research indicates a way which, in the very near future, should almost completely eliminate the difficulties.

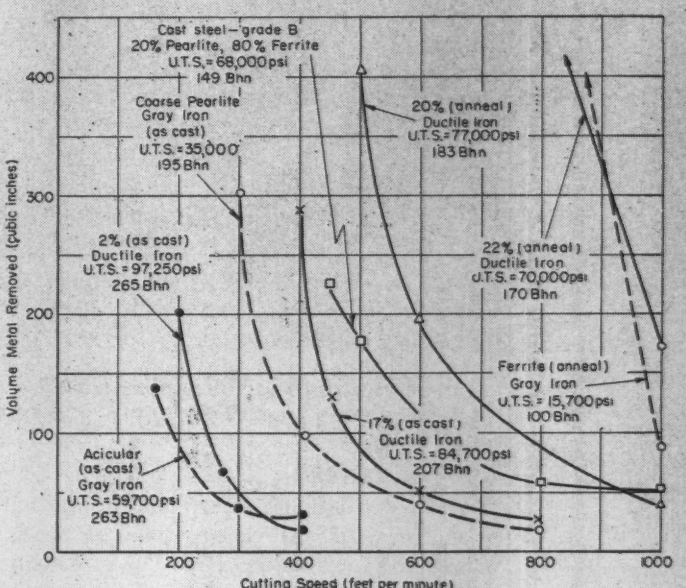
Use of Chills: In casting gray iron it is common practice to use metal mold inserts, called chills, at various points to effect improved soundness and greater hardness at some surfaces of the casting. An example of this is the metal ring supported in a sand mold for a conventional freight car wheel. The ring produces a chilled wearing rim, in which the extent of chill is accurately controlled as to depth. Some difficulty has been experienced with smaller ductile-iron castings in controlling the depth of such a chill, even on simple surfaces of uniform thickness. The problem varies, of course, from one shape of casting to the next, and may not occur in some applications. When chilling is impractical, ductile iron can be surface hardened by flame or induction heating and will respond to heat treatment in suitable sections to approximately 55 to 60 Rockwell C hardnesses.

Use of Inserts: Another foundry practice, used with extremely hard grades of iron or steel, is the casting of soft metal inserts at points where machining is required. This practice is not necessary for ductile iron, which machines quite easily, *Fig.* 4. Inserts of a different kind, however, may be cast as easily in ductile iron as in gray iron. For example,

Fig. 2—Left—Charts showing expected range of properties versus section thickness based on tests of Y-block specimens

Fig. 3—Below — Photomicrographs of the various types of ductile iron clearly show the nodular character

Fig. 4—Below — Chart showing comparative machinability of ductile irons, steel and gray irons by speed and volume. Courtesy, International Nickel Co.



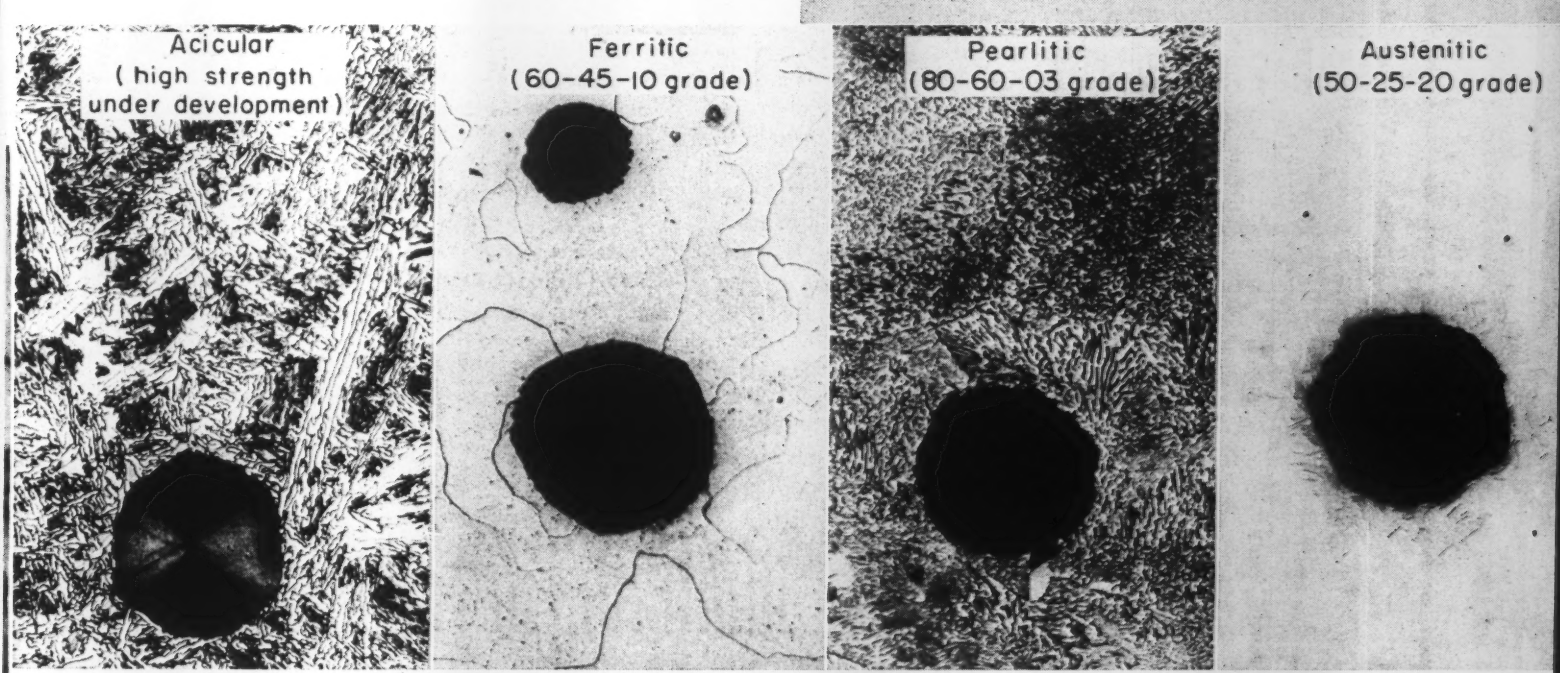


Table 1—Minimum Mechanical Properties of Ductile Irons & Competitive Materials

Properties	Ductile Irons			Cast Steels		Malleable Irons		Gray Irons		Nonferrous		
	Pearlitic	Ferritic	Austenitic	Pearlitic	Pearl-Ferr**	Pearlitic	Ferritic	A. Mech.	E. Mech.	Mn Bronze	Red Brass	Al Alloy (Cu Si)
	80-60-03	60-45-10	50-25-20	90-60 A148-46T	60-30 A27-46T	60003 A220-48T	32510 A47-48	Class 50 A48-48	Class 30 A48-48	B147-49-8A	85-5-5-5 B145-49-4A	ARI-CI B26-46T
Tensile Tests												
Tensile strength, psi	80,000	60,000	50,000	90,000	60,000	80,000	50,000	48,000	28,000	65,000	30,000	32,000
Yield strength, 0.2% offset, psi.	60,000	45,000	25,000	60,000	30,000	60,000	32,500	40,000	20,000	25,000†	14,000†	20,500†
Total elongation, %	3	10	20	20	24	3	10	0.6	0.5	20	20	2.0
Reduction of area, %	2	8	12	40	35	.....	18	.....	.....	15	25	.....
Mod. of elasticity, psi × 10^6	24	22	19	30	30	25	25	18.5	12.5	13.5	11.5	10.6
Brinell hardness, Bhn 3000 kg.	240/275	165/185	120/140	190/240	130/170	195/240	110/145	205/235	175/200	85/120§	45/60§	60/70§
Section size sensitivity	Appreciable HT under ½"	None All HT	Slight	.....	.....	1" max	1" max	½" min	Slight	None	None	.....
Fatigue Tests												
Endurance ratio, fs/ts not notched	0.48	0.46	.....	0.42/0.50	0.42/0.50	.....	0.50	0.33/0.46	0.33/0.46	0.25	.....	0.33
Endurance ratio, fs/ts notched ..	0.30/0.35	.....	.....	0.20/0.25	0.20/0.25	.....	0.33	.....	0.20/0.25	.....	.....	.....
Impact Tests												
Charpy, ft-lb	.....	.....	.....	15/20	15/20	.....	12/22	7.2	2.1	.....	.....	1.6
Izod, ft-lb	.....	.....	.....	.....	.....	.....	16.5	.....	.....	20/40	6/17	.....
ASTM type Y, not notched, ft-lb	18	100	220+	.....	220+	.....	.....	3	1	.....	.....	.....
ASTM type Y, notched, ft-lb...	1	5	15	.....	.....	.....	.....	1	1	.....	.....	.....
Machinability‡												
Volume cutting speed, ft/min...	310	970	.....	.....	.....	.....	.....	310	325	.....	.....	.....
Time cutting speed, ft/min.....	315	680	.....	.....	.....	.....	.....	280	320	.....	.....	.....
Analysis (nominal)												
Total carbon	3.60	3.60	2.7/3.2	0.50	0.30	2.50	2.50	3.00	3.40	.....	.....	.....
Combined carbon	0.75	0.20	.....	0.50	0.30	0.45	0.20	0.75	0.60	.....	.....	.....
Manganese	0.40	0.40	1.9/2.5	0.75	0.60	0.45	0.45	0.90	0.70	0.25	.....	0.30
Phosphorus	0.50	0.05	.....	0.04	0.04	0.10	0.10	0.10	0.50	.....	0.04	.....
Sulphur	0.02	0.02	.....	0.05	0.05	0.10	0.10	0.12	0.16	.....	.....	.....
Silicon	2.50	2.50	2.2/3.0	0.50	0.60	1.00	1.00	1.50	2.25	.....	.....	1.0
Nickel	0.75	0.75	21/26	.....	.....	.....	.....	.....	.....	0.25	0.75	.....
Molybdenum	.....	.....	.....	.....	.....	0.50	.....	.....	.....	.....	.....	.....
Copper	.....	.....	.....	.....	.....	.....	.....	.....	.....	57.5	Bal.	4.4
Tin	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.75	5.0	.....
Lead	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.25	5.0	.....
Zinc	.....	.....	.....	.....	.....	.....	.....	.....	.....	Bal.	5.0	0.3
Aluminum	.....	.....	.....	.....	.....	.....	.....	.....	.....	0.75	.....	Bal.
Iron	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.	Bal.	1.00	0.3	0.8
Physical Properties												
Density, lb/cu. in.	0.26	0.26	.....	0.28	0.28	0.26	0.26	0.26	0.26	0.30	0.32	0.10
Specific gravity ratio	7.15	7.15	.....	7.84	7.84	7.40	7.32	7.43	7.02	8.4	8.7	2.80
Solidus, F.P., F.	2130	2130	2200	2620	2680	2090	2090	2100	2120	1675/1725	1810/1840	1020/1195
Electric and Magnetic Properties												
Electric resistance, micro ohms cc	50	.....	.....	15	14	39	32	50	78	.....	.....	.....
Magnetic or nonmagnetic	M	M	N	M	M	M	M	M	M	N	N	N
Thermal Properties												
Coef. of exp. 70-600 F. in./in./° F. × 10^6	7.0	6.5	10.0	6.8	6.7	6.6	6.5	6.3	6.2	12.0	10.6	12.7
Miscellaneous												
Relative damping capacity	5	4	.....	2	1½*	.....	.....	24	32	.....	.....	.....
Patternmaker's shrinkage, in./ft	5/32*	0*	3/16*	3/16	3/16	3/16	3/16	5/32	1/10	7/32	3/16	.....
Wet Sand A.F., Wt loss/Wt loss SAE 1020 annealed	0.95*	0.96	0.85	.....	0.90*	.....	0.96*	0.99	1.09	.....	.....	.....
Dry sand abrasion, life compared to SAE 1045 normalized	85*	73	60	.....	90*	.....	.....	80	71	.....	.....	.....

* Denotes data which needs confirmation. † 0.5% offset. § 500 kg.
** Forged steel, type C, ASTM spec A235-49T has tensile requirements almost identical to this grade.
‡ Volume cutting speed is for tool life corresponding to 200 cubic inches of metal removed. Time cutting speed is for tool life of 60 minutes.

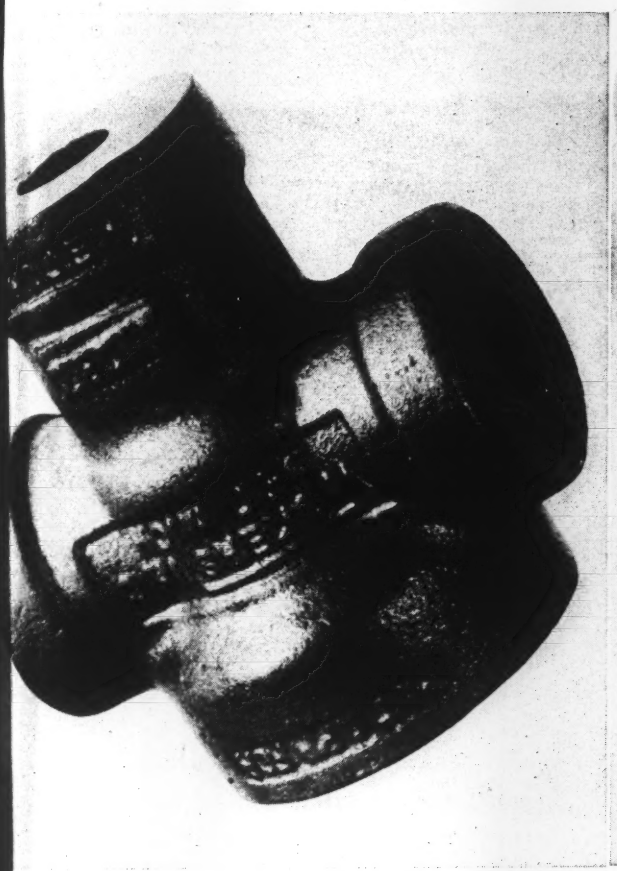


Fig. 5—Ductile-iron casting for a valve housing used in a high-pressure hydraulic system

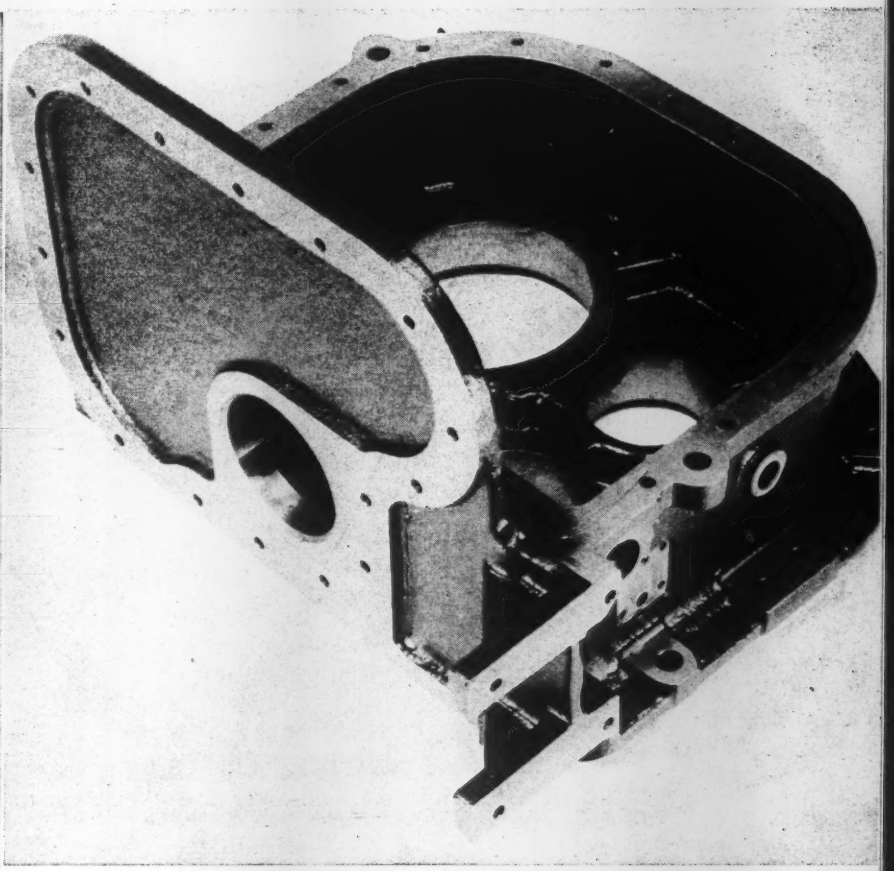


Fig. 6—Cast ductile iron fire control housing showing complex design practicable

the blades of a turbofan could be cast in place where the complications of pattern making would be excessive and tolerances required are not extremely fine.

Design Advantages: The advantages of ductile iron have been expounded to a considerable extent elsewhere. For purposes of comparison, TABLE 1 is included which rates the characteristics of ductile iron and some competitive materials. The table is not presented as complete or correct in all details, as many of the figures represent only interim conclusions established during investigation at our foundries. Some advantages which have not been pointed out in the table will be discussed briefly here.

Ductile iron possesses a resistance to oxidation which is somewhat better than that of gray iron, probably due to the presence of nickel and possibly because of higher silicon content. Because of these elements its corrosion resistance is equal to that of cast iron and, in some media, definitely higher. The creep of ductile iron at higher temperature is intermediate between that of gray iron and cast steel. For the same degree of machinability, ductile iron has twice the strength of gray iron. It also machines more easily than mild steel.

With regard to pressure tightness, ductile iron castings are superior to gray-iron castings, partly because of the spheroidized graphite. In gray cast iron the scatter of graphite flakes is evidently sufficient, under high pressure, to present leakage paths which are not found in ductile iron. Ductile iron can be cast sound about as easily as a class 50 iron, and it may often substitute for steel castings, or for bronze castings where corrosion resistance is not a requirement, *Fig.* 5. Ductile iron may be welded to iron or steel, or hardsurfaced by welding on a layer of hardfacing material. Welding techniques for the various grades of ductile iron are not firmly established but preheating is usually recommended for large castings. Postheating is generally desirable for maximum machinability and strength. This postheating may be difficult if adequate facilities are lacking.

Design Considerations: Except for some of the limitations previously described, foundry practices used in the production of ductile iron are equivalent to those used for gray iron, and the designer can generally proceed on this basis, *Fig.* 6. Feeding requirements are a little more difficult for ductile iron and it will help if the designer keeps direction of solidification in mind and provides uniformity of section wherever possible, *Fig.* 7. Cope surfaces are usually selected by the foundry, and may be hard to predict at the design stage. A surface to be machined should not coincide with the cope and, if unavoidable, should be extended an extra ⅛-inch to allow machining off of cope defects. Any design which depends upon the use of metal chills or sections under ½-inch in thickness should be discussed with the foundry at an early stage. Co-ordination between designer and foundry

Fig. 7—Cast ductile iron machine cover showing design to obtain good section uniformity

will always produce the best results fastest, and this is especially true of ductile iron, where rules are not yet hard and fast.

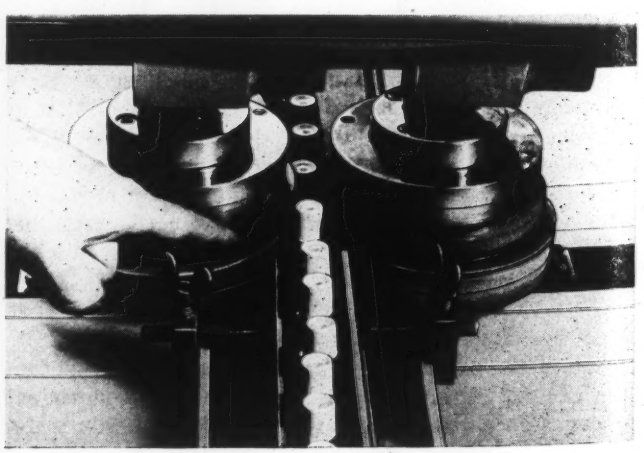
Conditions Justifying Application: The following list of conditions justifying application of ductile iron is again tentative, and will undoubtedly be greatly expanded with the advent of greater experience and higher tonnages. It is general only, and in many cases an application will offer unique reasons for the adoption of ductile iron.

1. Replacement of steel castings where easier casting or machining produces economy. Complicated shapes, heavy sections, and intricate machining operations are items worth investigating.
2. Replacing gray iron where greater strength or shock resistance is required.
3. Replacement of large, heavy-sectioned malleable iron castings where easier casting effects economy.
4. Replacement of forgings where quantities do not justify die expense or where straight die blocks are used for irregular shapes.
5. Replacement of steel, bronze, or other metal in short supply where ductile-iron characteristics are satisfactory for a specific job.

Plastic Wheels Tighten Bottle Caps

TWO vinyl plastic disks, called tightening wheels, provide the counter-rotating action which tightens fingernail polish bottle caps at Revlon Products Inc. Each urea plastic closure must be screwed down to an exact degree of tightness, a difficult task which required frequent adjustment of the rubber wheels formerly used.

Abrasion was another problem solved by the Goodrich Geon paste resin. The knurled plastic cap exerts a severe cutting action, particularly on the wheel that rotates against the forward motion of the cap and tightens it onto the neck of the bottle. Rubber wheels had to be replaced every 8 hours, and needed frequent adjustment as their surfaces wore away. Present wheels last 160 hours.



PRODUCTION AND

DESIGN

Modern Practices in Manufacture

Redesign for Fabrication

Important materials and cost savings achieved by redesigning jet-engine blades for rolling and welding

A NEW method for manufacturing jet blades which will crack the bottleneck in the aircraft turbojet engine production program has been developed at the G. E. Thomson Laboratory. The process involves fabrication of the stationary, or stator, blades of jet compressors in place of the relatively slower and more expensive forging techniques currently used.

Cost reductions of 55 per cent in stator blade manufacture will be possible through fabrication. Critical material savings are estimated at 39 per cent because of virtually chipless production which reduces waste.

Substitution of these fabricated blades for forged blades in the stationary sections of J-47-GE-23 turbojets for the jet-powered Boeing B-47 Stratojet, has been approved by the Air Force. An idea of total savings possible can be gained from the fact that current J-47 production models, on which these blades will be used, have approximately 2000 compressor blades, more than half of which are on the stator. Rotary blades will continue for the present to be forged because of the high centrifugal stresses involved.

In steam turbine manufacture blades are rolled in

(*Concluded on Page* 224)

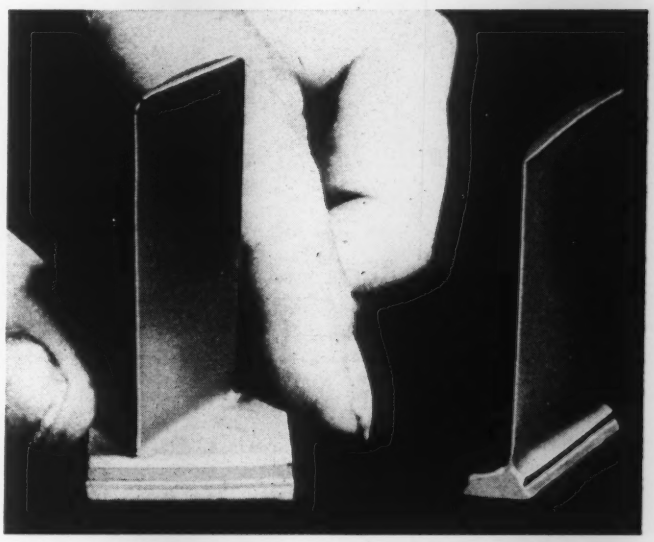


Fig. 1—Above—Complete fabricated jet engine blade, left, used in the stator portion of the compressor and, right, the forged blade currently used in production

Fig. 2—Below—Close-up of the stator of a G. E. J-47 jet engine compressor showing how fabricated blades are simply inserted into place in slots in the compressor casing. The other blades shown are forged and are inserted in a blade ring

Fig. 1—Spring-applied ac brake is relased through linkage operated by pull-type solenoid. Split band construction provides maximum wearing surface

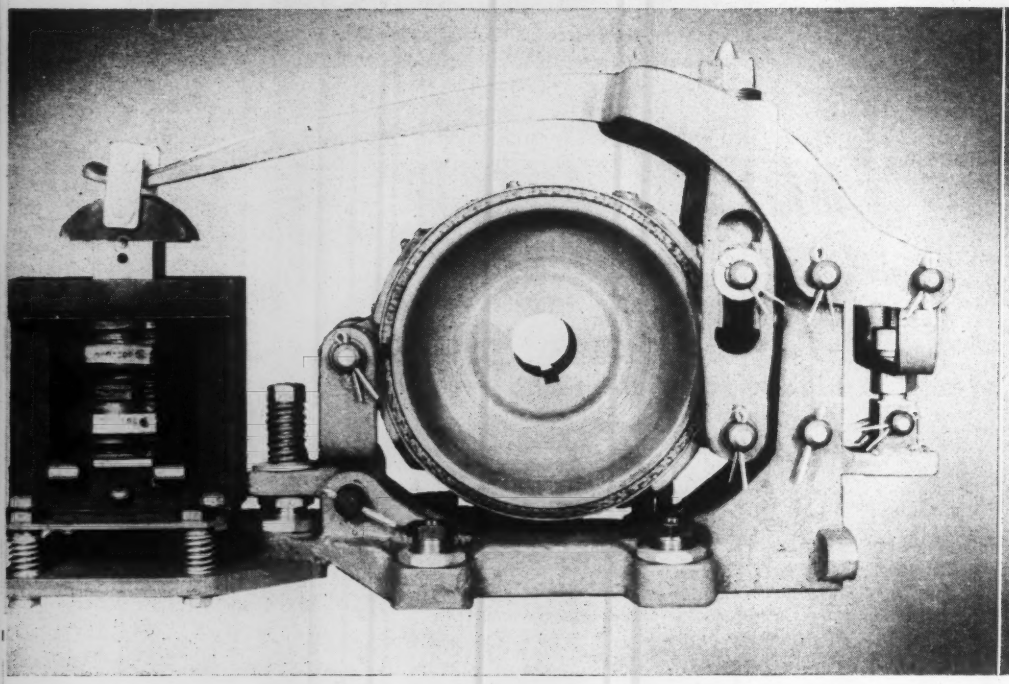
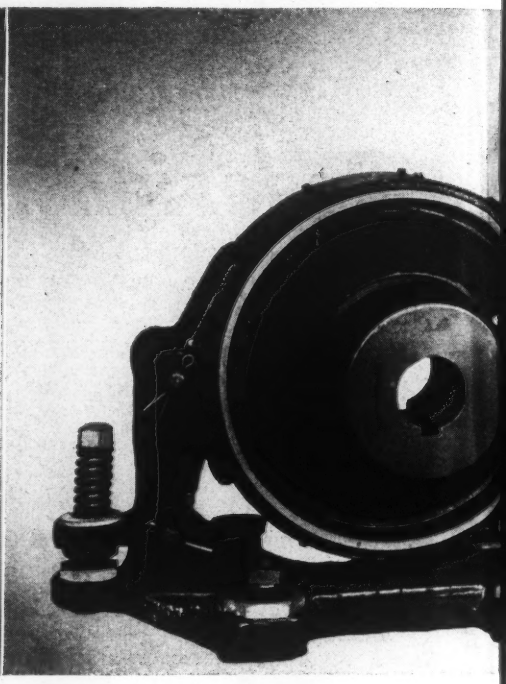


Fig. 2—Shoe construction of hinged armature ac brake is similar to the solenoid-



Electromechanical Brakes

. . . their char

By Robert C. May
Sales-Service Engineer
The Clark Controller Co.
Cleveland, Ohio

ELECTROMECHANICAL friction brakes, used in machine drives, provide controlled deceleration of large masses, accurate stopping and positioning of machine members, timed braking action co-ordinated with other machine functions, and emergency braking service for safety of personnel and machine. For these and other forms of service, a variety of commercial brakes is available from which a selection generally can be made. This article will set forth the electrical and mechanical characteristics of the various brakes ordinarily used, and factors that should be considered in selecting a brake will be outlined.

General Classifications: Electrically controlled mechanical brakes are of the shoe, disk, or band type and may be actuated by either alternating or direct current. Principal forms of ac brake actuators generally used to release spring-applied brakes are the solenoid, the hinged armature, the electro-hydraulic thrustor, and the torquemotor screw thrustor.

The ac solenoid operated brake, *Fig.* 1, may be identified readily by its solenoid frame which is laminated to reduce eddy currents. In addition, since the magnetic flux is continually changing, shading coils are employed to maintain constant pull on the armature. A mechanically similar brake, *Fig.* 2, is operated by a hinged armature.

Large ac brakes may be operated by a self-contained hydraulic thrustor, *Fig.* 3. When this brake is energized, oil is pumped from the top to the bottom side of a piston, causing it to rise and, through a linkage mechanism, release the brake. When the brake is de-energized, a spring forces the piston back into the cylinder, and the oil is returned above the piston. In applications where the brake load is heavy it is sometimes desirable to apply the brake gradually. This can be accomplished by means of a control valve built into the thrustor, permitting time delay adjustment, usually from one to twenty seconds.

Brake release in the torquemotor thrustor brake is accomplished through a motor-driven screw, which

ctuated brake in *Fig.* 1. Brake is applied by spring when coil is de-energized

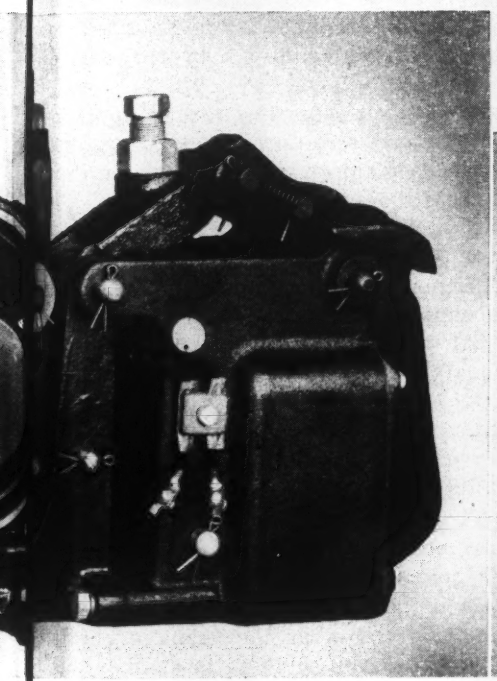


Fig. 3—Hydraulic thrustor brake requires separate fluid power source for operation. However, gradual application of brake is possible through fluid control

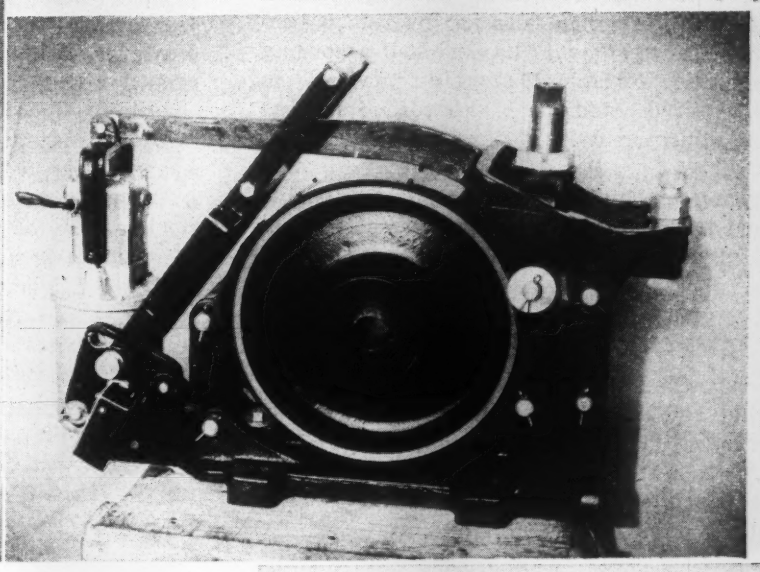
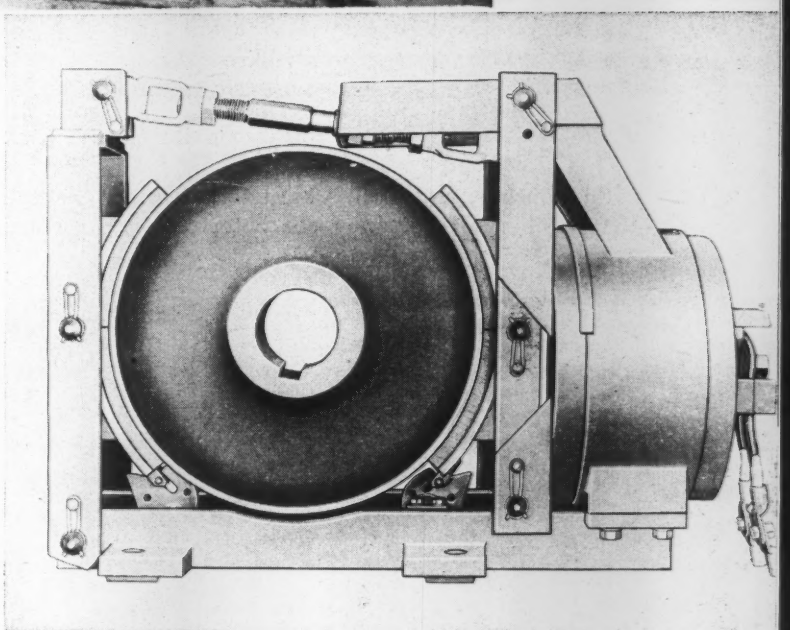


Fig. 4—Below, right — Direct operating magnet of dc shoe brake has short stroke enabling rapid setting and release for accurate stopping control



istics ***and selection in accordance with duty requirements***

in turn operates a linkage connected to the brake shoes. When the brake is fully released, the motor is stalled. De-energizing the motor allows a torque spring to drive the motor in reverse, thus applying the brake.

Fig. 4 shows a typical dc shoe brake with direct operating magnet. When the coil is energized the shoes are pulled away from the brakewheel. When de-energized, the shoes are thrust against the wheel by a heavy-duty spring. The dc solenoid-operated brake, similar to *Fig.* 1, is used where smaller brakes are required for stopping or holding a load.

In order to gain the same degree of efficiency in brake performance on ac as on dc, rectified ac is sometimes employed to operate dc brakes.

How To Choose Proper Size Brake: Considering known requirements, the machine designer should first determine the proper size brake for a specific duty. As will be discussed later, the brake size indicated may automatically preclude the use of certain types of actuators and friction devices, thus somewhat simplifying the selection.

Manufacturer's catalogs list the maximum torque rating of brakes in pound-feet, the corresponding wheel size, the type of operation for which the brake is recommended, and various other pertinent details. Braking torque required to stop a machine may be calculated on the basis of motor horsepower by applying the formula:

$$T = 5250\frac{P}{n}$$

where T = brake torque, lb-ft; P = motor rating,

hp; and n = speed of brakewheel, rpm.

Once torque is calculated through this formula, reference to a manufacturer's catalog will establish which size brake is recommended for the particular application. A brake should always be selected to have a nominal torque rating greater than T as figured by the formula.

Torque rating specified in brake catalogs usually are based on static conditions, as in "holding" brakes. Since coefficients of friction decrease as velocity increases, catalog ratings should be devalued according to brake speed. For example, if stopping service from 900 fpm is required, nominal brake torque ratings would drop to approximately 75 per cent of the static rating.

When rotating machinery must be stopped within an established time limit, the stopping time is specified by the following relationship:

$$t_t = t_1 + \frac{Wk^2n}{308T}$$

where t_t = specified time limit, sec; t_1 = interval between signal and actual lining contact, sec; W = weight of rotating mass, lb; k = radius of gyration of mass, ft; n = speed of brakewheel, rpm; and T = rated brake capacity, lb-ft.

In machinery having linear motion, as in *Fig.* 5, total stopping time is specified by the relationship:

$$t_t = t_1 + \frac{WV^2}{12{,}100Tn}$$

where V = velocity of linear moving mass, fpm.

Shoe, Band, and Disk Characteristics: In general, the shoebrake, *Fig.* 4, is characterized by its short stroke and fast operation. Band brakes are built with the friction material engaging a high percentage of the wheel's surface. Theoretically this type of lining provides long life, since retarding action is obtained with low braking pressure. To utilize the band brake to full advantage, careful adjustment is required to distribute braking pressure equally over the entire band.

Disk brakes are used on some low torque applications where their compact structure is advantageous. However, a low heat-dissipating characteristic disqualifies this brake for large applications.

Brake Actuator Characteristics: In general, dc brakes, operated either by clapper or solenoid should be used where accuracy in stopping is extremely important. In actual practice, however, the selection of a brake is usually predicated on motor operating current. Beyond this, decision to use a dc or an ac brake should be based on duty requirements.

A dc operating magnet has both short stroke and low inertia, making fast releasing and setting of the brake possible. These magnets have a long life, and comparatively low power consumption.

In general, dc solenoids are similar to dc direct operating magnets in being fairly constant in speed of action. While it is true that the solenoid exerts excess pull during the early part of its stroke, this is useful in overcoming static friction. Near the end of the stroke, the pull of the solenoid and the brake spring force nearly balance. Unfortunately, in order to gain full advantage in a solenoid brake, it is necessary that the solenoid have a long stroke which results in highly stressed moving parts. The longer travel of the solenoid armature naturally provides somewhat slower operation than the "clapper"

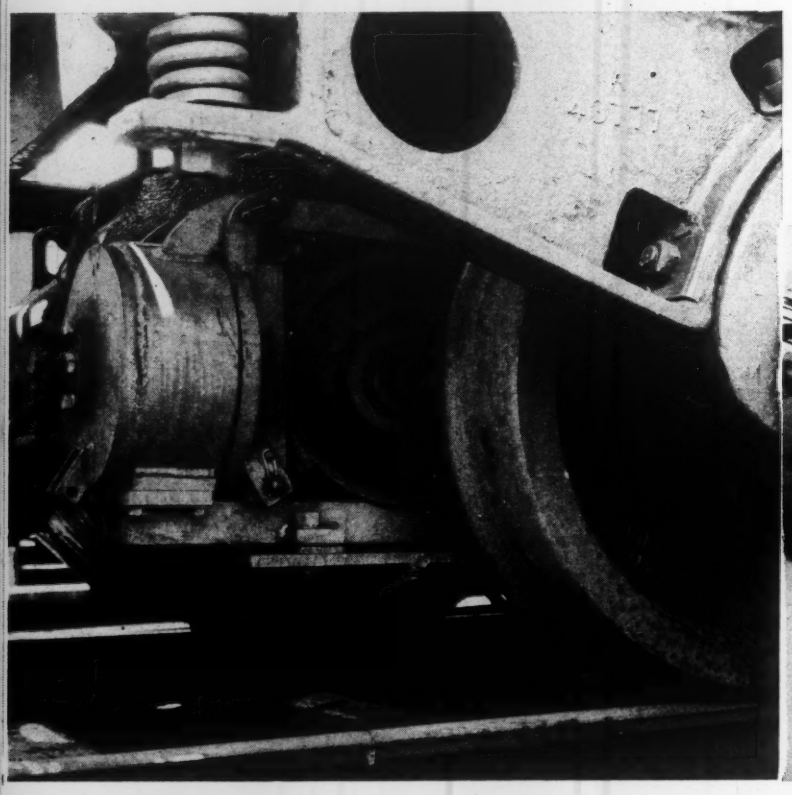
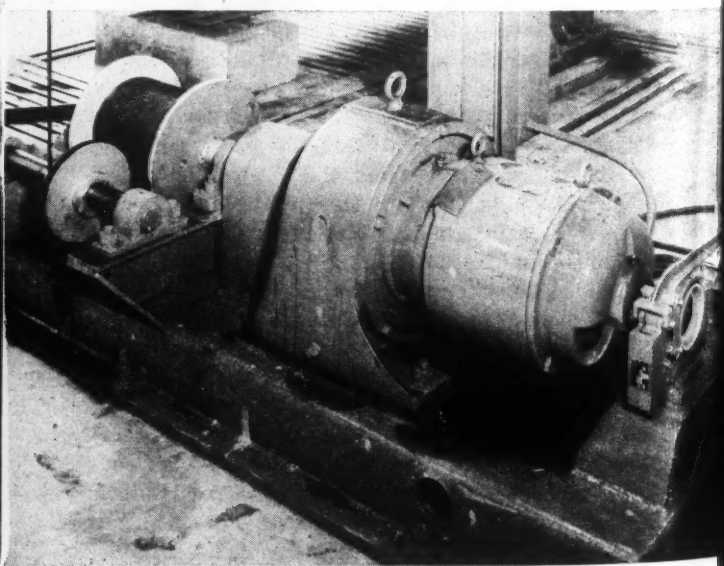


Fig. 5—Left—Hot metal transfer car with dc magnetic brake installed on traction motor housing. Brake is normally applied when motor is stopped

Fig. 6—Below—Looping tower winch drive is controlled by small ac solenoid-release brake. Brakewheel is mounted directly on shaft extension of 3-hp motor



or the direct operating magnet.

Alternating current solenoids have found considerable application, *Fig.* 6, in conjunction with small brakes. They are comparatively simple in construction, although not as simple as dc solenoids. In addition, they have a rapid release and setting time. However, as brake size increases, the disadvantages of this type of unit become increasingly pronounced. One inherent disadvantage springs from the fact that the initial pull is obtained through high inrush current, which results in high power losses. Should the solenoid fail to seat properly, this high current will continue and eventually result in coil burnout. Furthermore, improper seating usually causes the noisy vibration known as "ac hum." In general, this type of unit is justified only for smaller applications with short duty cycles.

Large ac brakes are preferably either hydraulic-thrustor operated or are equipped with a torquemotor actuator. Both of these operators compare favorably with solenoids in being quiet and smooth setting because of adjustable time delays. The slow setting of the hydraulic thrustor brake is sometimes an advantage, as it permits applying the brake smoothly when a heavy mass of high inertia is to be stopped. Furthermore, inrush currents are considerably lower than for ac solenoids.

In connection with the hydraulic thrustor, however, it must be pointed out that the control system should provide for time-lag in brake release. This may amount to ½-second, and will vary with extreme temperature changes which affect the fluid viscosity. The thrustor brake has the disadvantage of requiring a continuously-running oil pump and motor to keep the brake released, and loss of oil or pump failure will make it inoperative. One disadvantage of the torque-motor actuator is that the motor can be energized in one direction only, which, in some control systems, necessitates additional equipment. However, like the hydraulic thrustor, it has an advantage over solenoid brakes in requiring a low inrush current.

The ac clapper type actuator possesses advantages over the solenoid type in having lower inertia and shorter stroke. However, it is similar to the ac solenoid in that it draws high inrush current. A variation of the clapper magnet is the so-called "hammerhead" magnet or hinged armature which projects inside the coil. Shown installed in *Fig.* 7, this actuator is similar to the clapper type, but it differs in having a higher initial closing pull, but a lower sealing pull, resulting in less magnet "slam."

Coil Characteristics: Manufacturer's catalogs show that braking torque varies with the rating of the magnet coil, and that for any particular brake the intermittent time rating will be greater than the continuous rating. Briefly, the reason for this is that in the final analysis, braking torque is dependent upon the power of the brake spring, and the magnet must be proportioned to overcome the spring force.

Assuming the magnet is to be energized on a continuous basis, only a certain amount of electrical energy can be dissipated in the form of heat to stay within a safe thermal range. However, within limits set by the heat capacity of the coil, the coil can dissipate a greater amount of power provided the period of energization is shorter.

SERIES COILS: A high percentage of dc brake coils are wound with relatively few turns of heavy wire and are arranged for connection in series with the drive motor. One inherent advantage of this arrangement is that if the motor circuit should accidentally be opened, the brake will set automatically. This is of particular advantage where the load is normally suspended. Other advantages of series coils are:

1. Series coils have low inductance, and therefore act quickly
2. Should a series-connected motor overspeed, coil current will reduce to a low value allowing the brake to set, thus reducing the possibility of runaway
3. The voltage between turns is so low that insulation breakdown seldom occurs.

Series wound brakes are used in dc circuits only and are usually rated at 1-hr and ½-hr duty. The 1-hr rating means that the brake is good continuously

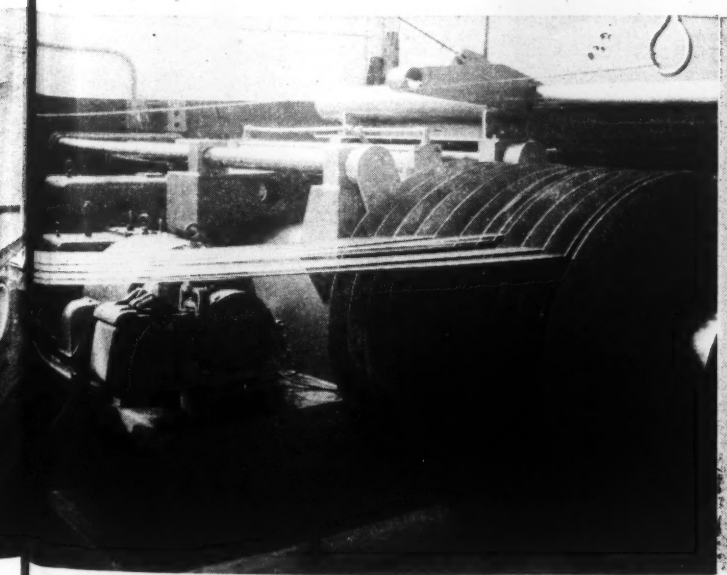
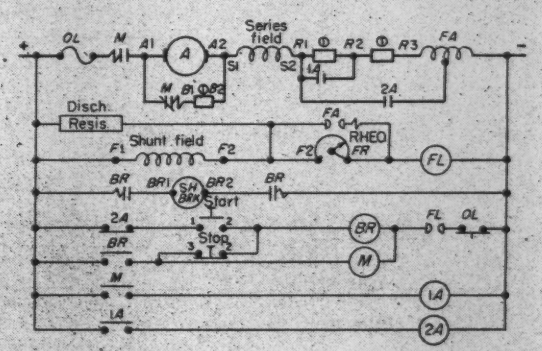


Fig. 7—Left—Medium sized holding brake on 50-hp 1800-rpm motor of slitting line recoiler is ac-operated by hinged armature. Load is decelerated by dynamic braking

Fig. 8—Below—Diagram shows typical control interlock between dc shunt brake and motor. Brake relay operates motor starter



for one minute on, one minute off; or 1-hr maximum continuous energization. One-half hour rated series brakes are limited to ½-hr in the released position at one time, and not over one minute on and two minutes off continuously. Both brakes release on approximately 40 per cent of full-load motor current and will set if the current drops below 10 per cent of full load.

Obviously if the motor load is extremely low, the series brake may "chatter." If used on light drives requiring small brakes, the coil resistance then becomes a substantial part of the total circuit resistance, and when the brake coil is energized there may be a considerable drop in motor voltage and speed.

SHUNT COILS: In many applications shunt-wound brake coils are preferable—sometimes necessary. Invariably they are used on ac, while on dc circuits they must be used where there is a widely varying load. For example: in elevator and mine hoist service, the load current may pass through zero and flow in either direction depending upon whether the motor hoists or retards. Under these conditions a series brake could not be held in release.

Shunt coils, both ac and dc, also are wound for either continuous or intermittent duty. All ac shunt-wound brakes, when set for rated braking torque, will release at 85 per cent of normal voltage. All dc shunt-wound brakes operate at 80 per cent of normal voltage.

COMPOUND COILS: Brakes having both series and shunt coils are not uncommon. The series coil is usually in the circuit for a short period to give quick release. It is then short circuited by control, leaving a comparatively light shunt winding to hold the brake in release.

Control Circuits: *Fig.* 8 shows the control diagram for a shunt brake in a simple dc circuit. The control represented is for a compound-wound dc motor and might be used in machine tools, fans, blowers, pumps, etc. In this circuit, when the start button is pressed, brake relay *BR* is energized, closing the shunt brake coil circuit and causing the brake to release. Simultaneously, an auxiliary contact on *BR* energizes the coil of contactor *M* starting the motor.

Since ac brakes are always used in shunt, the basic circuit for their application is generally similar to that shown in *Fig.* 9. Referring to this circuit diagram, current going to the motor also energizes the brake coil. In case of a power failure, the brake will set automatically. Control circuit shown is for the shear motor used on a combination slitting and shearing line.

Unless auxiliary control equipment is employed, a full-voltage shunt brake tends to be more sluggish than a series brake. This is caused by the higher inductance of the shunt coil, which retards the "building up" or "dying down" of the flux. In order to alleviate this condition, many shunt coils, particularly for the larger brakes, are wound for partial voltage and connected in series with a resistance. This permits a high current inrush and gives quick release. Two schemes for securing snap action in shunt windings are depicted in *Fig.* 10.

Often it is desirable to have a "drift point" in a drive control; that is, a point in controller operation where the motor is de-energized but the brake coil is not. Obviously, this is feasible with a shunt brake only. The shunt brake also has some advantage in that its control circuit may be interlocked by relays to provide protective features.

An apparent advantage of the series coil over the shunt coil is the safety feature inherent in the position of the series brake coil, inasmuch as de-energizing the motor permits the brake to set. In shunt brake circuits, this feature may be duplicated partially by using a relay having its coil in series with the motor circuit while the contacts are in series with the brake coil. When the motor is started, the relay is energized, and its contacts close to release the brake. An electrical interlock across the relay contacts provides a brake holding circuit to keep the brake energized on low armature current which otherwise might drop out the relay. Unfortunately, this control scheme protects only against releasing the brake with the armature circuit open originally. It does not protect against opening the circuit once the motor has started.

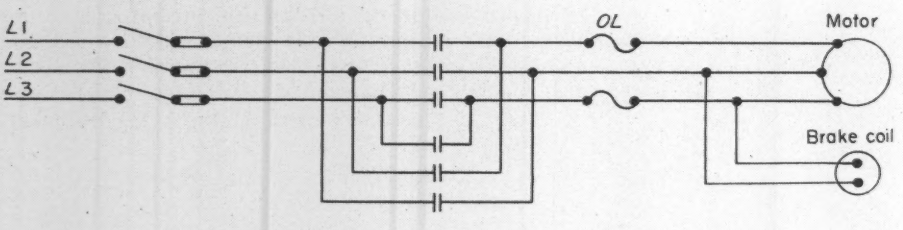


Fig. 9 — Left — Diagram shows usual method of connecting ac solenoid brake in parallel with motor. De-energizing motor applies brake

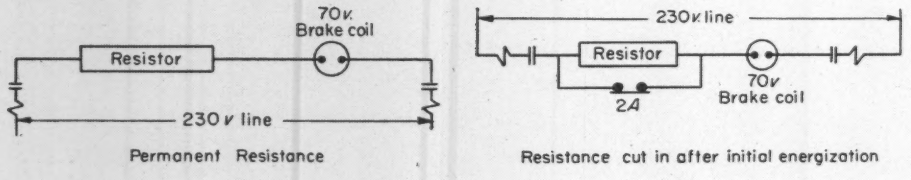


Fig. 10—Diagram shows resistors in series with brake coils to secure snap action in shunt connected brakes. This enables use of low-voltage coils at minimum expense

Selection of Flat Rubber Belts

. . . aided by chart giving factors for different angles of contact

PROPER selection of a belt starts with a determination of the maximum power to be transmitted. This factor is obtained usually by multiplying the rated horsepower of the driving unit (the name-plate rating) by a service factor which represents the overload on the drive during starting. This method presumes, of course, that proper consideration of the power required by the driven unit has already entered into the selection of the driving unit. Overload varies with both the type of drive unit and the type and use of the driven unit.

A list of service factors, TABLE 1, is presented in this article for use in design together with a horsepower capacity chart, *Fig.* 1, which is a rapid aid in determining horsepower rating per inch of belt width per ply of belting.*

A belt is described in terms of width, w, and number of plies, p. Their product, wp, which represents the ply-inch of fabric in the belt necessary to carry the load, is determined by dividing the chart value of horsepower per inch per ply into the total horsepower, including the starting service factor involved. Other considerations, such as the existing pulley face width and good belt proportioning, TABLES 2 and 3, dictate selection of the actual width and the corresponding number of plies required by the wp product.

Any belt in the table of well proportioned belts having the calculated wp product, or next above the calculated value, is satisfactory provided pulley diameters are not too small. See TABLE 2. In practice, the widest possible belt for a projected drive is preferred. Hence, a thinner belt with greater flex life results.

The wp-product is

$$wp = \frac{Pf}{P_b} \qquad (1)$$

where P = rated power of the driving unit, hp; f = service factor for application and drive from TABLE 1; and P_b = power capacity of belt, hp per inch per ply for the fabric selected at the belt speed and angle of belt contact involved. P_b is obtained from the horsepower capacity chart, *Fig.* 1.

Belt speed is

$$V = 0.262 D_d n \qquad (2)$$

where V = belt speed, fpm; n = speed of the drive pulley, rpm; and D_d = diameter of drive pulley, inches.

Angle of belt contact, expressed as a conservative approximation, is

$$\theta = 180 - \frac{60\,(D - d)}{C} \qquad (3)$$

where θ = angle of belt contact, deg; D = diameter of the larger pulley, inches; d = diameter of the smaller pulley, inches; and C = center distance between pulleys, inches.

Equation 3 gives the smaller angle of belt contact. If an idler is used, it is safe to estimate the belt angle from the position of the idler on the new belt, usually about 10 deg more than calculated with Equation 3.

The horsepower capacity chart is based on the following relationships:

$$P_b = \frac{V(T_1 - T_c)\left(1 - \frac{1}{e^{\mu\theta}}\right)}{33{,}000} \qquad (4)$$

$$T_c = \frac{WV^2}{3600g} \qquad (5)$$

$$e^{\mu\theta} = \frac{T_1 - T_c}{T_2 - T_c} \qquad (6)$$

where T_1 = proper tight-side tension for fabric in-

* Much of the content of this article, including *Fig.* 1, has been prepared by Newell Perry, Flat Belting Engineer, Thermoid Co., Trenton, N. J.

Data Sheet

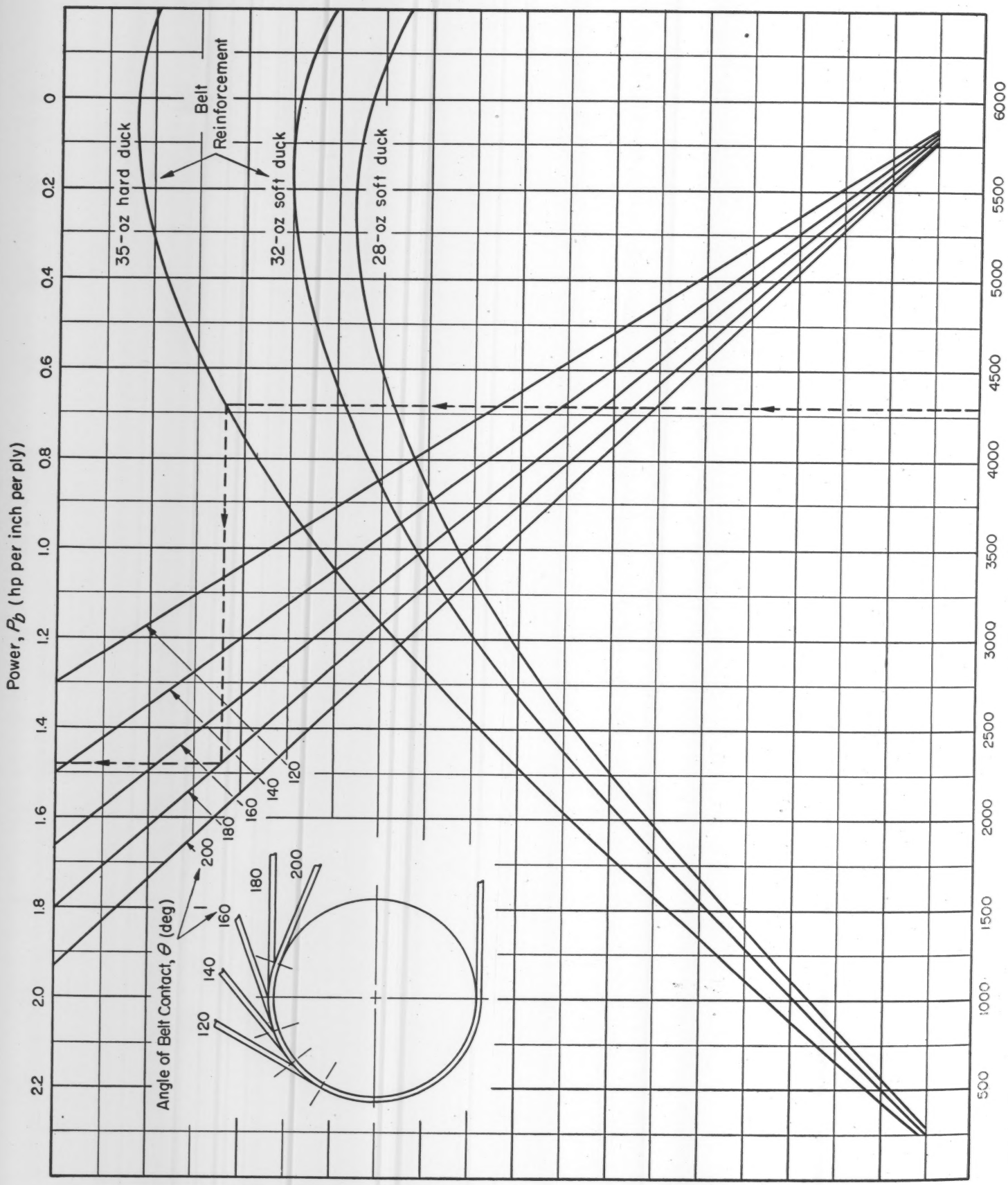


Fig. 1—Chart for determining horsepower capacity of rubber belts with various reinforcements in terms of belt speed and contact angle. Dashed line shows solution sequence

Table 1—Service Factors for Flat Belts

Applications	AC Motors								DC Motors		Engines				Misc.
	Normal Torque Line Start	Normal Torque Compensator Start	High Torque	Wound Rotor (Slip Ring)	Normal Torque	High Torque	Repulsion and Split Phase	Capacitor	Shunt Wound	Compound Wound	4 or More Cyl. Above 700 rpm	4 or More Cyl. Below 700 rpm	3 or Less Cyl. (Refer to Mfr.)	Steam	Line Shafts and Clutch Starting
	—(Squirrel Cage)—				(Synchronous)		(Single Phase)				—(Gas and Diesel)—				
Agitators															
Liquid	1.2	1.0	1.4	1.2	...	...	...	...	...	...	...	...	...	...	...
Semi-Liquid	1.0	1.0	1.2	...	...	...	...	...	...	...	...	...	...	...	...
Brick and Clay Machinery															
Auger Machines	...	1.2	1.4	1.4	...	...	...	...	1.4	...	...	...	...	...	2.0
De-Airing Machines	...	1.2	1.4	1.4	...	...	...	...	1.4	...	...	...	...	...	2.0
Cutting Table	...	1.2	1.4	1.4	...	...	...	...	1.4	...	...	...	...	...	2.0
Pig Mill	1.5	1.3	1.8	1.5	...	...	...	...	...	...	...	...	...	...	2.0
Mixer	...	1.2	1.6	1.4	...	...	...	...	...	...	...	...	...	...	...
Granulator	...	1.2	1.4	1.4	...	...	...	...	...	...	...	...	...	...	...
Dry Press	...	1.2	1.6	1.4	...	...	...	...	...	...	...	...	...	...	...
Rolls	...	1.2	1.4	1.4	...	...	...	...	...	...	...	...	...	...	...
Compressors															
Centrifugal	1.2	1.2	...	1.4	1.4	...	...	...	1.2	...	1.2	...	...	...	...
Rotary	1.2	1.2	...	1.4	1.4	...	1.2	1.2	1.2	...	1.2	...	...	...	...
Reciprocating—															
3 or More Cyl.	1.2	1.2	...	1.4	1.4	...	...	...	1.2	...	...	...	...	...	...
1 or 2 Cyl.	1.4	1.4	...	1.5	1.5	...	...	...	1.2	...	...	...	...	...	...
Conveyors															
Apron	...	1.4	1.6	...	...	...	...	...	1.4	...	...	...	...	...	1.6
Belt (Ore, Coal, Sand)	...	1.2	1.4	...	...	...	...	...	1.2	...	...	...	...	...	1.4
Belt (Light Package)	...	1.0	1.1	...	...	...	...	...	1.0	...	...	...	...	...	1.2
Oven	...	1.0	1.1	...	...	...	...	...	1.0	...	...	...	...	...	1.2
Screw	...	1.6	1.8	...	...	...	...	...	1.6	...	...	...	...	...	1.8
Bucket	...	1.4	1.6	...	...	...	...	...	1.4	...	...	...	...	...	1.6
Pan	...	1.4	1.6	...	...	...	...	...	1.4	...	...	...	...	...	1.6
Flight	...	1.6	1.8	...	...	...	...	...	1.6	...	...	...	...	...	1.8
Elevator	...	1.4	1.6	...	...	...	...	...	1.4	...	...	...	...	...	1.6
Crushing Machinery															
Jaw Crushers	...	1.4	1.6	1.4	...	...	...	...	...	1.4	1.4	...	...	...	1.6
Gyratory Crushers	...	1.4	1.6	1.4	1.4	1.6	...	...	...	1.4	1.4	...	...	...	1.6
Cone Crushers	...	1.4	1.6	1.4	...	...	...	...	...	1.6	1.4	...	...	...	1.6
Crushing Rolls	...	1.4	1.6	1.4	...	...	...	...	...	1.4	1.4	...	...	...	1.6
Ball—Pebble	...	1.4	1.6	1.4	1.4	1.6	...	...	...	1.4	1.6	...	...	...	1.6
Tube Mills	...	1.4	1.6	1.4	1.4	...	...	...	...	1.4	...	...	...	...	1.6
Fans and Blowers															
Centrifugal	1.2	1.2	...	1.4	...	...	...	1.2	1.2	...	...	...	...	...	...
Propeller	1.4	1.4	2.0	1.6	...	2.0	...	1.4	1.4	...	...	...	...	...	...
Induced Draft	1.2	1.2	...	1.4	...	...	...	1.4	1.4	...	...	...	...	...	...
Positive Displ. Blowers	1.6	1.4	...	2.0	2.0	2.0	...	...	1.6	...	...	...	...	...	...
Exhausters	1.2	1.2	...	1.4	...	...	...	1.4	...	...	...	...	...	1.5	1.5
Generators and Exciters	1.2	...	...	...	...	...	...	...	1.2	...	2.0	...	...	1.4	1.4
Line Shafts	1.4	1.4	...	1.4	1.4	2.0	1.4	1.4	1.4	1.4	1.6	...	...	1.6	1.6
Machine Tools															
Grinders	1.2	...	...	1.4	...	...	1.2	1.0	1.2	1.2	...	...	...	...	...
Boring Mills	1.2	...	...	1.4	...	...	...	...	1.2	1.2	...	...	...	...	...
Lathes	1.0	...	...	1.2	...	...	1.0	1.0	1.0	1.0	...	...	...	...	...
Milling Machines	1.2	...	...	1.4	...	...	...	...	1.2	1.2	...	...	...	...	...
Screw Machines	1.0	...	...	1.0	...	...	1.0	1.0	1.0	1.0	...	...	...	...	...
Cam Cutters	1.0	...	...	1.0	...	...	...	...	1.0	1.0	...	...	...	...	...
Planers	1.2	...	...	1.4	...	...	1.2	1.0	1.2	1.2	...	...	...	...	...
Shapers	1.0	...	...	1.0	...	...	1.0	1.0	1.0	1.0	...	...	...	...	...
Drill press	1.0	...	...	1.0	...	...	1.0	1.0	1.0	1.0	...	...	...	...	...
Drop Hammers	1.0	...	...	1.0	...	...	1.0	1.0	1.0	1.0	...	...	...	...	...
Shears	1.2	...	...	1.4	...	...	1.2	1.2	1.2	1.0	...	...	...	...	...
Mills															
Pebble	...	1.4	1.6	1.4	...	...	...	...	...	1.4	...	...	...	...	1.6
Rod	...	1.4	1.6	1.4	...	...	...	...	...	1.4	...	...	...	...	1.6
Ball	...	1.4	1.6	1.4	...	...	...	...	...	1.4	...	...	...	...	1.6
Roller Mills	...	1.4	1.6	1.4	...	...	...	...	...	1.4	...	...	...	...	1.6
Flaking Mills	...	1.6	1.6	1.4	...	...	...	...	...	1.4	...	...	...	...	1.6
Tumbling Barrels	...	1.6	1.6	1.4	...	...	...	...	...	1.4	...	...	...	...	1.6
Printing Machinery															
Rotary Presses	1.2	1.2	...	1.2	...	...	...	...	1.2	...	...	...	...	...	...
Embossing Presses	1.2	1.2	...	1.2	...	...	...	...	1.2	1.2	...	...	...	...	...
Folders	1.2	1.2	...	1.2	...	...	...	...	1.2	...	...	...	...	...	...
Paper Cutters	1.2	1.2	...	1.2	...	...	...	...	1.2	1.2	...	...	...	...	...
Linotype Machines	1.2	1.2	...	...	...	...	...	...	1.2	...	...	...	...	...	...
Flat Bed Presses	1.2	1.2	...	1.2	...	...	...	...	1.2	...	...	...	...	...	...
Pumps															
Centrifugal	1.2	1.2	1.4	1.4	...	...	1.2	1.2	...	...	...	...	...	...	...
Gear	1.2	1.2	1.4	1.4	...	...	1.2	1.2	...	...	...	...	...	...	...
Rotary	1.2	1.2	1.4	1.4	...	...	1.2	1.2	1.2	...	1.2	...	...	...	...
Reciprocating—															
3 or More Cyl.	1.2	1.2	...	1.4	1.4	1.6	...	...	...	...	1.8	...	...	1.8	...
1 or 2 Cyl.	1.4	1.4	...	1.6	1.6	1.8	...	...	...	...	2.0	...	...	2.0	...
Screens															
Vibrating	1.2	1.2	1.4	...	...	...	...	...	...	...	...	...	...	...	...
Conical	1.2	1.2	...	...	...	...	...	...	...	...	...	...	...	...	...
Revolving	1.2	1.2	...	...	...	...	...	...	...	...	...	...	...	...	...

volved, lb; T_2 = slack-side tension, lb; T_c = centrifugal tension, lb; e = Naperian logarithm base = 2.71828; μ = coefficient of belt-pulley friction; θ = angle of belt contact, radians; W = weight of belting per inch of width per ply per ft of length, lb; and g = gravitational acceleration, 32.2 ft per sec per sec.

For belting weight W, an average value of 0.03 lb has been employed in the chart. Also, for coefficient of friction μ, a value of 0.22 is built into the chart and holds for dry, cast-iron or steel pulleys with friction reinforced belting.

It will be noted that the three curves of 28, 32, and 35-oz fabric achieve horsepower maxima between belt speeds of 5000 and 6000 feet per minute. Normal high speed is 4000-5500 fpm, medium speed 3000-4000 fpm, and low speed 2500-3000. Still lower speeds are possible, of course, but are often impractical.

A belt with the proper wp factor and of good proportions according to TABLE 3, should be examined for flexibility by checking plies against pulley diameters in TABLE 2.

Table 2—Pulley Diameters Versus Belt Plies

Number of Plies	Pulley Diameter (in.) 35-oz Hard Duck Normal	35-oz Hard Duck Minimum	28 & 32 oz Soft Duck Normal	28 & 32 oz Soft Duck Minimum
3	4	7	4	6
4	6	9	6	8
5	8	12	8	10
6	10	15	10	14
7	12	18	12	16
8	14	22	14	20
9	16	26	16	24
10	18	30	18	28

* Use normal diameters for best results. Pulleys larger than normal may be used.

EXAMPLE: Determine the belt width and number of plies for an installation with following initial design conditions: motor rating P = 40 hp, speed n = 1000 rpm, service factor f = 1.4, drive pulley diameter D_d = large pulley diameter D = 18 inches, driven or small pulley diameter d = 12 inches, center distance C = 54 inches. Belt speed is first determined from Equation 2:

$$V = 0.262\ (18)\ (1000) = 4716 \text{ fpm}$$

Next, from Equation 3, belt contact angle is calculated:

$$\theta = 180 - \frac{60\ (18 - 12)}{54} = 173 \text{ deg}$$

With the 32-oz material first assumed, enter *Fig.* 1 at 4700 on the V scale, proceed upward to the 32-oz curve, then horizontally to the 173-deg contact angle line (interpolated), and finally upward to the P_b scale where the result is 1.28 hp. per inch per ply.

From Equation 1,

$$wp = \frac{40\ (1.4)}{1.28} = 44 \text{ ply-inches}$$

This requirement is most nearly satisfied on the upper side by the following belt proportions from TABLE 3: 8 inches wide, 6 ply, wp = 48. According to TABLE 2, a 12-inch pulley and 32-oz material may be used safely with a 6-ply belt. Slightly longer service life would result with the alternate specification: 10 inches wide, 5-ply, wp = 50.

When pulleys are smaller than the recommended minimum diameter, the sizes of both pulleys should be increased unless a thinner belt of heavier fabric will suffice. The normal pulley diameters of TABLE 2 allow maximum belt life. As diameters become smaller, fatigue of rubber and fabric, resulting in "bootlegging" and splice failure, also increases. Since the tension ratio, $(T_1 - T_c)/(T_2 - T_c)$, tends to be less than 2.00 as the pulley size approaches the minimum limit in TABLE 2, because more tension is applied than actually required, the use of minimum size entails greater installation care to obtain maximum belt life and is not as safe.

Table 3—Standard Rubber Belting

Belt Width (in.)	Number of Plies and wp Factor (No.)	(wp)	(No.)	(wp)	(No.)	(wp)	(No.)	(wp)
2	3	6	..	..	..	...	4	8
3	3	9	4	12	..	...	5	15
4	3	12	4	16	..	...	5	20
5	4	20	..	..	..	...	5	25
6	4	24	5	30	..	...	6	36
8	4	32	5	40	..	...	6	48
10	4	40	5	50	..	...	6	60
12	5	60	6	72	..	...	7	84
14	5	70	6	84	..	...	7	98
16	5	80	6	96	..	...	7	112
18	5	90	6	108	7	126	8	144
20	5	100	6	120	7	140	8	160
22	5	110	6	132	7	154	8	176
24	6	144	7	168	..	...	8	192
26	6	156	7	182	8	208	9	234
28	6	168	7	196	8	224	9	252
30	7	210	8	240	9	270	10	300
36	7	252	8	288	9	324	10	360
42	7	294	8	336	9	378	10	420
48	7	336	8	384	9	432	..	...
48	..	...	10	480	11	528	12	576

Analog Computers

DESIGN ABSTRACTS

By C. B. Crumb Jr.
Boeing Airplane Co.
Seattle, Wash.

COMPUTING machines are not mechanical brains in any but a very remote sense; nor are they fundamentally new methods of attack on physical problems. They do, however, represent remarkable developments of older mathematical aids, facilitating many problem solutions which formerly required more effort than could economically be expended.

This paper is primarily concerned with one of the two principal types of computing machines which was first given the name *differential analyzer*. Recently the terms *analog computer* and *simulator* have become more popular. All three denote the same class of devices.

Analog computers, as used here, denote machines for determining the behavior of physical systems by the technique of simulation. By physical systems is meant the assemblages of physical elements such as mechanisms, electric circuits, chemical processes, heat processes, etc. Mathematical statements of the behavior of such systems take the form of differential equations; their solutions describe the variation of dependent variables as functions of independent variables. The technique of simulation uses "models" for the various quantities of the problem system. These models behave, mathematically, in the same way as their physical counterparts. Often, the models are completely dissimilar, except in the behavior sense, from the problem variables which they represent, thus they are called analogs. For every significant condition and feature of the problem there is an analog in the machine.

Forming the other large class of computing machines are the digital computers. Familiar examples of this class are office adding and bookkeeping machines. Much more elaborate examples are the high-speed, high-capacity programmed digital computers based on relay or electronic trigger circuits. All are arithmetic machines operating on quantities which change in discrete steps. In contrast, the analog computers, working with continuously variable quantities, might be called calculus machines.

Shown in *Fig.* 1 is a mechanical differential analyzer. All computing operations are performed in fundamentally mechanical fashion, and all analogs are shaft positions or rates. In *Fig.* 2 is an electronic analog computer in which computing operations are performed by electronic circuits, and various voltages are analogs of problem quantities. The electronic-mechanical analog computer of *Fig.* 3 utilizes both mechanical and electronic operations as well as analogs.

The basic mathematical operation which distinguishes analog computers is integration. Primary variables of each problem are generated by integration of their derivatives. The heart of each of these machines, then, is the integrator, and its precision, response and reliability are important factors in machine quality.

To be useful a simulator must be

Fig. 1—Mechanical differential analyzer. Computing operations are performed mechanically by using shaft positions or rates to simulate physical quantities; nonlinear functions are fed into system from the sloping input tables which can be seen at the left of the machine

capable of other operations besides integration. For general utility, it must also have devices for addition and multiplication by a constant. With these three kinds of elements, the machine is a linear analog computer, able to simulate linear systems; meaning systems describable by ordinary linear differential equations.

All too frequently, cases are encountered which cannot be treated realistically in terms of linear equations. For these it becomes desirable to have various simulator elements which generate trigonometric functions, simulate limit stops, obtain the product of two variables, inject an arbitrary function of a variable, and perform other nonlinear operations. The most significant differences in machines appear in the types and varieties of nonlinear function capabilities.

Various sizes, costs and complexities of the three example machines, *Figs.* 1, 2 and 3, can be traced mainly to nonlinear function capacity. The limiter is the only type of nonlinear element incorporated in the small electronic machine shown in *Fig.* 2. This computer is very inexpensive. While it has astonishingly wide applicability, it is not as versatile as the mechanical simulator. The four input-tables with sloping tops, *Fig.* 1, arranged along the left side of the machine, permit the injection of various continuous nonlinear functions, some obtained automatically and some obtained manually. Other nonlinearities of the discontinuous type, such as backlash and stops, may be handled in the mechanical interconnection and transmission system.

The electronic-mechanical simulator, *Fig.* 3, incorporates: means for generation of trigonometric functions of variables in two different ways, devices for multiplication and division of variables, arbitrary function generators, "noise" or random signal generators, and other nonlinear capabilities, all operating automatically. These devices make it extremely versatile and also quite costly. Thus, various degrees of capacity can be obtained in simulators, with prices varying accordingly. Users

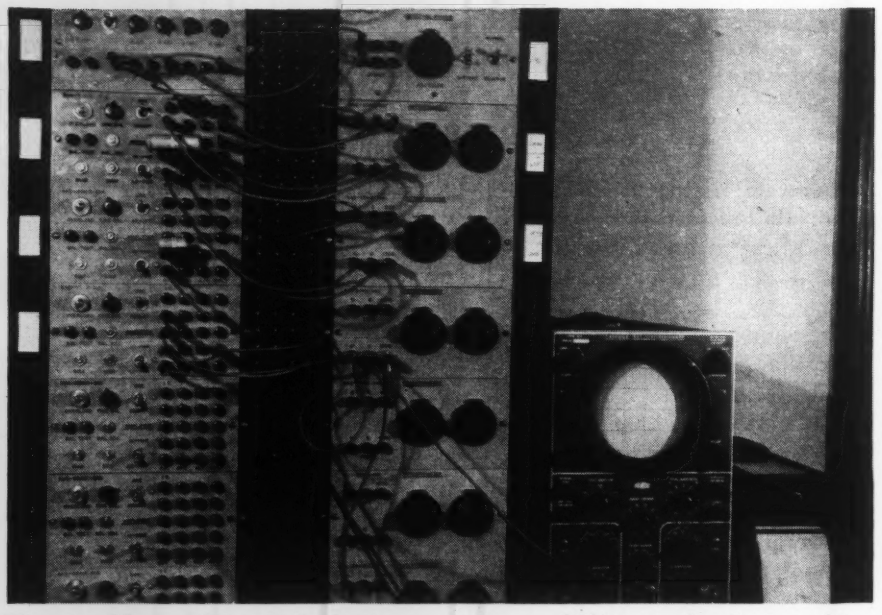
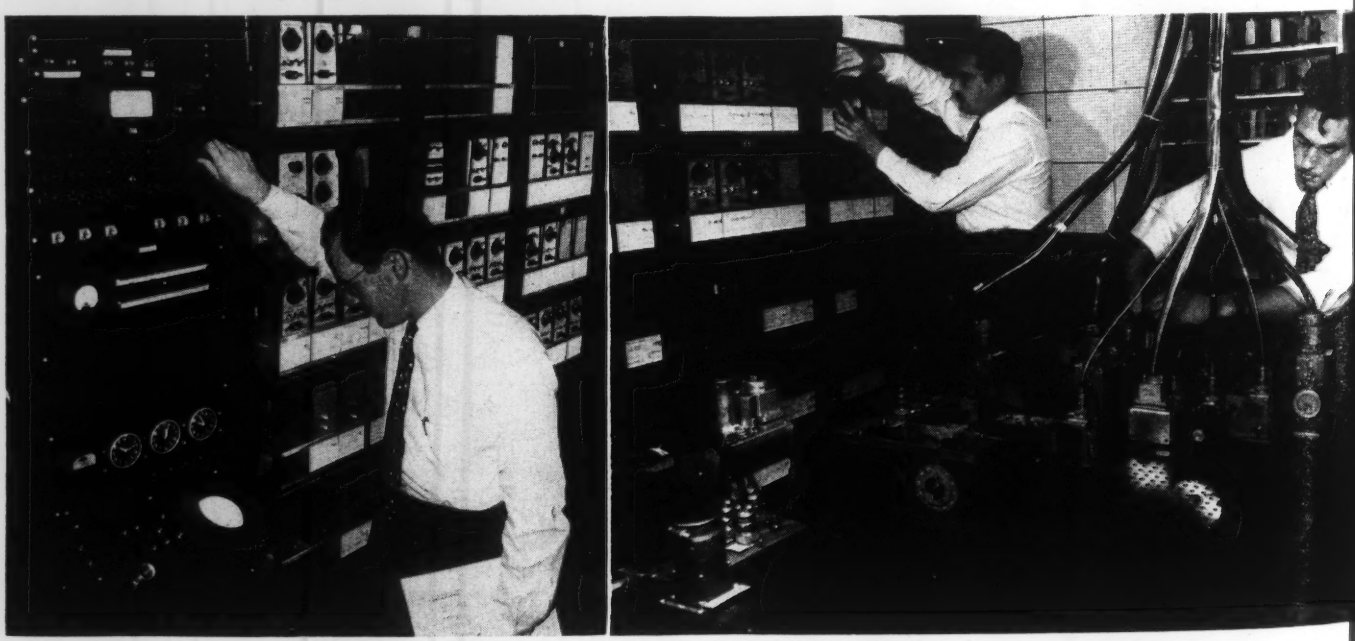


Fig. 2—Above—Electronic analog computer. Voltages simulate problem quantities and electronic circuits perform computations. Arrangement of wires and dials on control panel dictates integrating processes which furnish a solution on the oscillograph at right

Fig. 3—Below—Electronic-mechanical analog computer. The two views show the complex nature of this simulator which utilizes both electronic and mechanical operations. In the view at the left the viewing oscilloscope is being adjusted while in the view at the right electrical and mechanical sections are being aligned for a problem solution



of such computing aids should examine their needs carefully before selection among the several different machines available.

There are various ways in which the analog computer can be employed. The most important are:

1. Simulation of a complete dynamic system. For a designed apparatus, the simulator answers the question of how it will perform
2. Experimental determination of parameters for optimum performance of complex dynamic systems. The simulator provides an easy means of experimentation with gain factors, gear ratios, corrective networks, etc.
3. Simulation of part of a dynamic system, the balance of which is incorporated in its true form. For example, using the analog computer to simulate airplane dynamics, an actual airplane autopilot can be flight tested
4. Experimental synthesis of part or all of a dynamic system. Design of a specific computer for a navigation system may be accomplished by simulating that system and inserting simulated specific computer designs
5. Training of operators in control of complex systems. The example in 3 might well be expanded to include automatic landing equipment and a pilot's cockpit. This would constitute a flight trainer which would be assembled and operated at a small fraction of actual training cost.

These machines are predominantly applicable to problems of dynamic systems, and in particular to dynamic systems in which the basic variable is time.

Control Systems: An already large and still rapidly expanding area of application is in analysis and design of closed-cycle automatic-control systems, or servomechanisms.

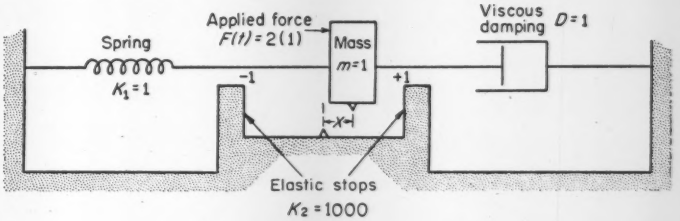
Whenever high performance is required of any of these servos it becomes subject to such evils as instability and uncertainty of rate of response or character of response. In such cases, economical development of the equipment requires that the performance of a proposed design be predicted. Usually, if the mathematical statement of the system is at all realistic, solving the equations analytically would be far too time consuming to be practical. Here the analog computer excels. The most common features which remove servo problems from the realm of linear mathematics—limits, backlash, saturation and static friction—are easily accounted for in simulator setups. All three of the machines shown in *Figs.* 1, 2 and 3 have been used extensively on problems of this type.

Passive Oscillatory Systems: These are basically mass-spring-damping systems. Included are not only mechanical cases, but the many electric, hydraulic, aerodynamic and others, describable by the same class of equations. Some specific examples in this category are spring suspensions for vehicle wheels, passive electric networks such as filters, aircraft control surfaces subject to flutter, compound pendula, shafts subject to torsional oscillation, and the infinite variety of vibration problems. Frequently, in these cases, the same sort of nonlinearities described for servos — limits, backlash, etc. — make manual solutions extremely laborious and sometimes impossible. Here again, with analog computers they are easy. All three of the representative simulators shown have also been applied to such problems.

Trajectory Calculations: Under this heading come such problems as trajectories of ballistic missiles and controlled missiles. The mechanical differential analyzer of *Fig.* 1 has been applied to electron ballistic problems. However, some problems in this category, particularly stellar ballistics, require high orders of precision; removing them from the realm of analog computers. When the answer must be known to five significant figures, it becomes a job for digital computers where precision of calculation is simply a matter of the machine

Fig. 4—Sample computer problem. From a diagram of the problem, equations are written and appropriate scale factors are assigned to relate computer quantities to their physical counterparts

Problem: Spring – Mass – Damper System with Elastic Stops



$$1\frac{d^2x}{dt^2} + 1\frac{dx}{dt} + X + G = F(t)$$

Unscaled Computer Equations:

$$\frac{dx}{dt} = \int\left[-\frac{dx}{dt} - X - G + F(t)\right]dt$$

$$X = \int\frac{dx}{dt}\,dt$$

$$G = \begin{cases} 1000(X-1) & X>1 \\ 0 & -1<X<1 \\ 1000(X+1) & X<-1 \end{cases}$$

$$F(t) = 2(1)$$

Computer Plan Chart:

Variable	Estimated maximum	How generated	Generator maximum	Scale factor
dx/dt	2	Op. Amp.	50	.04
X	1.05	Op. Amp.	50	.021
G	1000 X .05 = 50	Limiter controlled by X		21
F(t)	2	Volt box	45	.0444

Scaled Computer Equations:

Amplifiers

$$\frac{d\bar{x}}{dt} = -\frac{1}{.75}\int\left[\frac{.394}{1}\bar{X} + \frac{.75}{1}\frac{d\bar{x}}{dt} + \frac{\bar{G}}{.00256} - \frac{.833}{1}\bar{F}(t)\right]dt$$

$$-\bar{X} = -\frac{1}{5}\int\frac{.952}{1}\frac{d\bar{x}}{dt}\,dt$$

$$\bar{X} = -\left[-\bar{X}\right]$$

Limiter

$$\bar{G} = \begin{cases} \bar{X}-47.6 & \bar{X}>47.6 \\ 0 & -47.6<\bar{X}<47.6 \\ \bar{X}+47.6 & \bar{X}<-47.6 \end{cases}$$

Volt box

$$-\bar{F}(t) = -45\,[1]$$

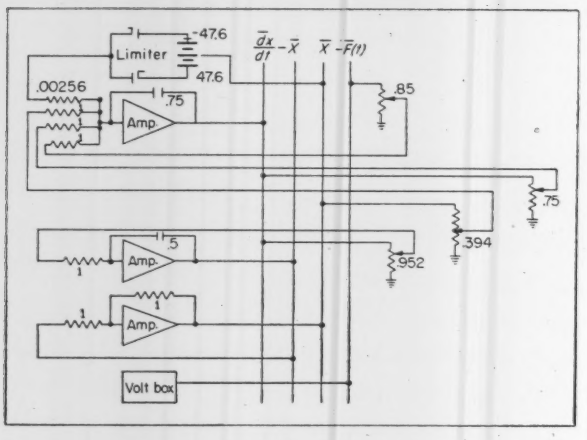


Fig. 5 — Computer hookup diagram. This circuit shows the connections used on the electronic computer, *Fig.* 2, to solve the problem in *Fig.* 4

capacity. If the end result is not so drastically affected by small biases and scale errors, as in controlled missile trajectories, the limited precision of the analog machine is adequate. The electronic-mechanical machine of *Fig.* 3 was designed primarily for simulation of controlled missile trajectories.

The value of the simulator in such problems is in the speed of obtaining solutions for different sets of conditions. Once the problem has been fed into the machine, a solution is produced in a matter of minutes or even seconds. A broad pattern of solutions representing many different combinations of conditions may be obtained in an hour or so.

Computation Procedure: The four-step procedure for analog computer operation is:

1. *Diagram*: Importance of the diagram, either a mechanical system sketch or a block diagram, as an aid to visualization and comprehension of a problem system cannot be over emphasized. In electrical problems, the block diagrams assume special importance if lines and blocks are labeled with symbolic statements of what they represent. The line quantities are often called "signals," and the block operations, "transfer functions."

2. *Equations and Scale Factors*: The second step is writing equations of the system and assigning appropriate scale factors relating machine quantities to problem quantities. These operations are greatly facilitated by a carefully labeled diagram.

3. *Machine Setup*: This process will vary widely with the different types and designs of computers. For the general purpose simulator, however, the process is fundamentally one of assigning the integrators to generate variables and connecting necessary computing chains, according to the equations, to feed the integrators. For the electronic computer, *Fig.* 2, after writing scaled equations, setup requires only plugging in wires and setting dials. However, where extensive mechanical hookup is involved, the setup operation becomes costly. Aligning, orienting and coupling gears and shafts can never proceed with the speed of plugging in wires.

4. *Machine Operation*: Once the setup has been completed, operation of the machine merely requires that the independent variable, or variables, start changing. In practically all commercial analog computers, the machine independent variable is time. Operation is then "starting time," which means making final application of power so that the integrating process begins. Solutions appear usually on the screen of a cathode ray oscilloscope, Fig. 3, on some form of oscillograph such as the one in *Fig.* 2, or on a plotting table, *Fig.* 1.

A sample problem, *Fig.* 4, and the corresponding connection diagram, *Fig.* 5, illustrate the use of the electronic simulator of *Fig.* 2. This problem demonstrates the four-step procedure described. It is a small problem when viewed from the standpoint of analog computer use. Complete machine treatment would require about two man-hours; by purely analytical means, time of the order of man-weeks would be needed.

Limitations: There are two basic reasons for restriction of the use of these machines to certain classes of problems. First, many problems do not justify treatment by such elaborate means. Second, the fundamental nature of the simulator rules out its use for certain classes of problem which do justify machine application. Just as a desk calculating machine is not used to perform the multiplication of five times eleven, a simulator is not justified for solution of a single second order linear differential equation. Generally speaking, use of the analog computer is advantageous where handling of a problem entirely by mathematicians becomes unduly laborious. The mathematical features which usually cause solutions to be "unduly laborious" are a large number of simultaneous equations, and nonlinearities. Because the computer is a calculus machine, utilizing continuously varying quantities within itself, it is inappropriate for basic arithmetic problems. Examples of such problems are census calculations, other statistical problems, cost accounting, banking, inventory, and time study calculations. These are problems in numbers, for which the digital machines should be used.

Another natural restriction is the limited precision. This arises in part from limitations in the individual computing devices—drift in integrators is a common example—and in part from the task of measuring the continuously varying quantities within the machine. The result is an overall precision limitation, generally to two or three significant figures. However, few dynamic problems are excluded by this limitation. In many of the investigations of dynamic systems, numerical answers are not usually desired. Rather, the information needed is the presence or absence of instability in the system, as well as the design of the devices to prevent instability.

Description of the division line between the groups of problems which do and do not require simulator aid is quite unspecific. It must remain so because of the variety of machines; it must always be a matter requiring engineering judgment. The rather long setup time required for simulators such as those shown in *Figs.* 1 and 3 usually make it uneconomical to use such machines for small problems. On the other hand, the electronic machine of *Fig.* 2 is fre-

(*Continued on Page* 242)

NEW PARTS AND MATERIALS

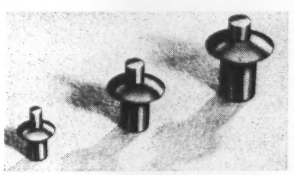
. . . presented in quick-reference data sheet form for the convenience of the reader. For additional information on these new developments, see Page 199

SMALL BLIND RIVET 1

. . . installed with ordinary hammer

Southco Div., South Chester Corp., 1418 *S. Penn Sq., Philadelphia* 2, *Pa.*

New ⅛-in. size is now available, along with $\frac{5}{32}$ and ¼-in. shank diam sizes previously offered.



Size: ⅛-in. shank diam; grip lengths, $\frac{1}{32}$ to $\frac{13}{32}$-in.

Service: Installed by tapping home pin with an ordinary hammer; for metal-to-metal or metal-to-wood installations; requires no bucking, special tools or access to rear side of work; with pin driven flush, head has neat finished appearance; no stems to trim off.

Design: Hammer-driven blind; driving the pin causes prongs at end of rivet to expand against the back sheet and form a permanent blind head that draws panels together; available with modified brazier or 100% countersunk heads.

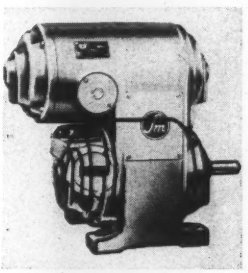
For more data circle MD 1, Page 199

VARIABLE SPEED DRIVE 2

. . . mounts in standard NEMA dimensions

Sterling Electric Motors Inc., 5401 *Anaheim-Telegraph Rd., Los Angeles* 22, *Calif.*

Mounting dimensions are interchangeable with NEMA standard motors.



Size: Single phase, 1 to 3 hp; polyphase, 1 to 15 hp.

Service: 2 to 1, 3 to 1, or 4 to 1 speed variation; saves cost of building special bases where interchangeability between drives and NEMA motors is desired.

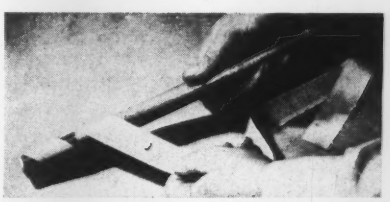
Design: V-belt variable-speed transmission with positively adjusted pulleys plus induction motor as integral unit; dripproof, splashproof or totally-enclosed.

For more data circle MD 2, Page 199

HEATING ELEMENTS 3

. . . in flexible tape form

Electrofilm Corp., 7116 *Laurel Canyon Blvd., N. Hollywood, Calif.*



These flexible elements are recommended by the manufacturer for application to cylinders and tubes.

Size: 115 v, 10-ft long; 27 v, 28-in. or 10-ft long; 1½-in. wide; width of heating surface, 1 in.

Service: Supplying 2.5 w per sq in.; recommended max temperature, 300 F.

Design: Film-type flexible continuous element; sold as package, including flexible tape, covering insulation, busses and bussing material.

For more data circle MD 3, Page 199

GREASE LUBRICANT 4

. . . contains pulverized lead dust

Knapp Mills Inc., 23-15 *Borden Ave., Long Island City, N. Y.*

High metallic lead content held in permanent suspension forms self-lubricating coatings over wearing parts for heavy-duty service.

Designation: Lead-Lube K, KM.

Form: Homogenous grease and metallic lead dust blend.

Size: Supplied in 25, 50 and 100-lb pails, 200, 300 and 500-lb drums.

Service: Protects actual working surfaces of gears and bearings by forming metallic-lead self-lubricating surface overlay; resurfaces pits and scores on old parts; helps resist water, moisture and corrosion; may be applied over other greases.

Properties: K has higher metallic lead content than KM and is for higher temperatures; KM for general heavy-duty use; base grease will not break down under high temperatures, speeds or pressures until after lead coatings form; metallic lead will not settle out of suspension.

For more data circle MD 4, Page 199

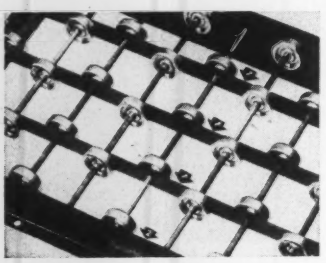
NEW PARTS AND MATERIALS

WHEEL CONVEYOR 5

. . . reinforced for extra strength

Rapids-Standard Co. Inc., Dept. IRS, 342 Rapistan Bldg., Grand Rapids 2, Mich.

Bulky roller conveyors can be replaced by this heavy-duty wheel conveyor.



Designation: Industrial Rapid-Wheel.

Size: 5 and 10-ft sections, 12 and 18-in. wide; 45 and 90-deg curves.

Service: Heavy-duty conveying with distributed load of 1 ton over 5-ft section possible.

Design: Multiple-wheel; 3½-in. deep channel frames of 12-gage steel; each lane of wheels is reinforced with steel center band which supports axles at points of greatest strain; available with tubular or channel-type guard rails, or may be used without guard rails.

For more data circle MD 5, Page 199

TEMPERATURE CONTROLLER 6

. . . provides straight-line control

Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Wayne & Windrim Aves., Philadelphia 44, Pa.

Close control is obtained on equipment where rapid heating rates, small heating capacity or abnormal lags are encountered.

Designation: Pulse Pyr-O-Vane.

Size: 6-in. indicating scale.

Service: Control of electrically heated or fuel-fired equipment; variable proportional band between 1% and 3% of full scale; periodic load relay actuation to suit requirements with cycle times of 3, 7.5, 12, 18, 30 or 72 sec; available for 115 v, 25 or 60 cycles ac, or 230 v, 50 or 60 cycles ac; relay contact rating, 5 amp.

Design: Time-proportioning indicating millivoltmeter controller; time-proportioning control unit consists of oscillator, amplifier and relay, with additional gear train, synchronous motor, eccentric aluminum vane and set of oscillator coils; calibrated adjustment changes proportional band setting; set of 16 change-gears vary cycle time; signal lamps in front of flush or surface-mounted case indicate control-unit relay operation; plug-in galvanometer and control units.

Application: Vacuum plastic molding equipment, plastic extruders, nylon heat-setting equipment.

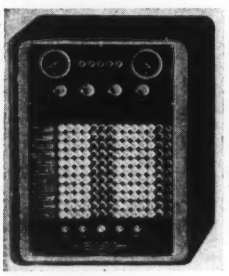
For more data circle MD 6, Page 199

OPERATIONS PRESELECTOR 7

. . . adjusts timing of multiple operations

Henry G. Dietz Co., Coral Designs Div., 12-16 Astoria Blvd., Long Island City 2, N. Y.

Shown is a unit for laundry machinery, which controls the temperature, time and water level for each of 11 wash cycles.



Designation: 125.

Size: Depends on design.

Service: Adjusts timing of each cycle independently; can energize a number of circuits during a single cycle; duration of one cycle can be changed without affecting others; available for ac or dc.

Design: Synchronous motor timer delivers a repetitious fixed-time impulse; multiples of this impulse are preselected with pushbuttons to control duration of individual cycle; custom built from standard parts; cycle progress can be shown with pilot lights; cabinets to provide dustproof and steam-tight housing available.

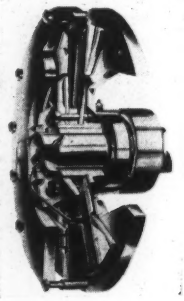
For more data circle MD 7, Page 199

AIR-OPERATED CLUTCH 8

. . . for heavy duty applications

Cardwell Mfg. Co. Inc., Clutch Div., P.O. Drawer 2001, Wichita, Kans.

Shaft space is claimed to be 20% less than the shortest clutch of any other design.



Designation: Flex-Disc.

Size and Service: Requires no adjustment; long friction-surface life due to uniform plate pressures and air-cooled operation; maximum torque capacity at point of slip with 80 psi air pressure as follows:

Plate Size (diam, in.)	1-Tube (1000 lb-in.)	2-Tube (1000 lb-in.)	3-Tube (1000 lb-in.)	4-Tube (1000 lb-in.)	Max Speed (rpm)
12	9	18	27	36	2000
16	25	50	75	100	1800
21¾	65	130	195	260	1500
25¾	116	232	348	464	1400
33¾	270	540	810	1080	1000

Design: 1, 2, 3 or 4 tubes and plates; compact, alloy-steel construction; large friction-face clearance when disengaged; disengaging springs prevent drag; "lock-in" device provided in case of air failure; heavy-duty ball bearings with mechanical shaft seal; air friction brakes of same general design, either spring-engaged and air released or vice versa, are available.

For more data circle MD 8, Page 199

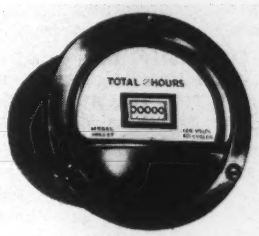
NEW PARTS

RUNNING-TIME METER 9

. . . hermetically sealed in drawn steel case

Marion Electrical Instrument Co., 421 *Canal St., Manchester, N. H.*

This meter is stated to be absolutely tamperproof.



Size: Fits 3½ in. mounting space.

Service: Registering operating time in 1/10-hr steps to 9999.9 hr, or 1 hr steps to 99,999 hr; tamperproof; performs in wide range of temperatures and in hazardous atmospheres; moisture and dustproof; magnetically shielded; for 110-125 v or 220-250 v, 50 or 60 cycles ac.

Design: Counter mechanism and self-starting synchronous motor are hermetically sealed in drawn-steel case; tempered glass crystal is fused directly to case.

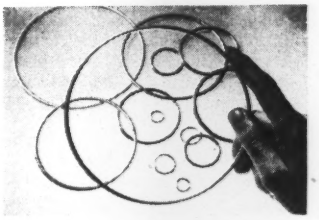
For more data circle MD 9, Page 199

METALLIC O-RINGS 10

. . . pressure-filled for static seals

United Aircraft Products Inc., 1116 *Bolender Ave., Dayton* 1, *O.*

Experimental quantities are available now, with full production expected by September.



Designation: UAP/Wills.

Size: $\frac{1}{8}$ in. to 40 in. OD in increments of $\frac{1}{16}$-in.

Service: As static seals under pressures as high as 20,000 psi; temperature and corrosion resistance limited only by physical characteristics of metal; positive metal-to-metal sealing; dimensionally stable under heat or cold; can be installed in present ring grooves, machined recesses or, with special limiting device incorporated in rings, without grooves or recesses; can be reused after joint is broken for servicing or inspection.

Design: Butt-welded hollow metal tubing filled with inert gas at 600 psi; stainless steel, or mild steel, cadmium or nickel plated.

Application: High-compression diesel engines; air compressor and vacuum equipment; fuel, exhaust and hydraulic systems; retractable undercarriages.

For more data circle MD 10, Page 199

VALVE PACKING 11

. . . eliminates stem pitting and electrolysis

Crane Packing Co., 1825 *Cuyler Ave., Chicago* 13, *Ill.*

Electrolytic action that attacks 410 and 416 chrome-steel valve stems during storage after hydrostatic test is short-circuited.

Designation: 187.

Size: Die formed to specified size with square or beveled mating ends, or for stuffing boxes.

Service: Side-tracks electrolysis and pitting action of valve stem occurring after hydrostatic test; temperatures to 850 F, pressures to 2000 psi on steam valves; contains no volatile or rubberized material that could harden in high-temperature service; minimum gland adjustment; easy stem operation.

Design: Braided of asbestos yarn around resilient graphite and asbestos core; impregnated with dry graphite lubrication.

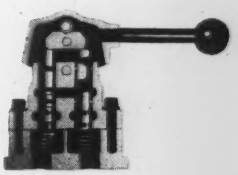
For more data circle MD 11, Page 199

AIR-CONTROL VALVES 12

. . . have fast, trouble-free action

Numatics, Milford, Mich.

Redesigned for longer life, the pins, rollers, rockers and upper poppets are now hardened.



Size: ¼, ⅜, ½ and ¾-in. pipe size.

Service: Control of pneumatic cylinders in range of 5 to 125 psi; fast action; working parts are readily replaced without disturbing piping by removing housing from base; in neutral position both poppets are closed to pressure and open to exhaust so that cylinder is static, without pressure at either end; lower seats are oil and impact resistant.

Design: Double poppet; neutral position of lever is maintained by 2 light springs underneath lower poppets; interchangeable rockers, either locking, nonlocking or combination, can be installed without disturbing installation; locking rocker is pressure-locked in engaged position; hardened pins, rollers, rockers, and upper wearing surface of lower poppets; high-tensile manganese steel casting rocker shield; brass poppets; bronze housing; vertical or horizontal handles; side or bottom ports.

For more data circle MD 12, Page 199

NEW PARTS AND MATERIALS

LAMINATED PLASTIC GROMMET 13

. . . can be compressed, inserted by hand

Continental-Diamond Fibre Co., Newark, Del.

Breakage and assembly troubles with molded cable grommets are eliminated with this springlike laminated plastic grommet.

Size: As follows; specials available; width depends on design;

OD (in.)	ID (in.)	—Width— (in.)	OD (in.)	ID (in.)	—Width— (in.)
1.03	0.75	0.29 or 0.37	1.88	1.50	0.33 or 0.41
1.38	1.00	0.33 or 0.41	2.25	1.75	0.37 or 0.45
1.55	1.25	0.33 or 0.41	2.50	2.00	0.37 or 0.45

Service: As cushioning, wearproofing or insulating material for control cables or electric wiring in bulkheads, firewalls or cabinets; mechanically and dielectrically strong; resists heat; unaffected by water and ordinary solvents, including hot oil, acids and weak alkalies.

Design: Rolled laminated-plastic tubing made with fine-weave canvas is cut into rings, grooved and beveled; diagonal slit releases tension, allowing ring to be compressed, then to snap into place in mounting hole.

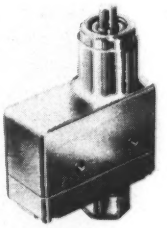
For more data circle MD 13, Page 199

WATERPROOF SWITCH 15

. . . designed to resist external icing

W. L. Maxson Corp., Unimax Switch Div., 460 W. 34th St., New York 1, N. Y.

Originally developed for aircraft landing gear and flap controls, this switch withstands the rigorous demands of all-weather service.



Designation: LK.

Size: 2⅛-in. long, ⅞-in. wide, 3½-in. high including operating plunger and terminal-cover cable bushing; weight, 0.35-lb.

Service: Rated 10 amp at 28 v dc; O-ring seals which prevent entrance of moisture to inside of housing can withstand pressure differential to 15 psi; nominal actuating force, 10 lb; force for full overtravel, 15 lb; pretravel, 0.093-in. max; overtravel, 0.187-in. min; differential, 0.032-in.

Design: Single-pole, double-throw; gasketed cover with sealed cable clamp provides splashproof protection for terminals, and anchors cables of 0.344-in. nominal diam; No. 6 binder-head screws for electrical connections.

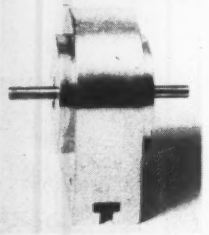
For more data circle MD 15, Page 199

PRECISION GEAR TRAINS 14

. . . in ratios up to 15,000 to 1

Bowmar Instrument Corp., 4214 Leo Rd., Ft. Wayne, Ind.

Originally developed for laboratory setups, these gear trains can also be used in instrument applications.



Designation: 107, 107U-A, -B, -C.

Size: 2¾-in. high, 2½-in. wide, 1⅜-in. thick plus shaft extensions.

Service: For instruments, laboratory servomechanisms, breadboard setups; maximum output torque at low shaft speeds, 5 lb-ft; less than 0.2 deg backlash unless otherwise specified; specials available to meet JAN and MIL specifications; 107U-A, -B, -C are laboratory units with interchangeable gear clusters; gear ratios as follows:

107—(preferred) 20, 25, 31.5, 40, 50, 63, 80, 100, 125, 160, 200, 250, 315, 400, 500, 630, 800, 1000, 1250, 1600, 2000, 2500, 3150, 4000, 5000, 6300, 8000, 10,000, 12,500, or 15,000 to 1; (special) 1.25, 1.6, 2, 2.5, 3.15, 4, 5, 6.3, 8, 10, 12.5 or 16 to 1
107U-A—(all supplied) 20, 40, 80, 160, 315, 630 and 1250 to 1
107U-B—(all supplied) 25, 50, 100, 200, 400, and 800 to 1
107U-C—(all supplied) 31.5, 63, 125, 250, 500 and 100 to 1.

Design: Steel gears; gears and bearings are precision hobbed; available mountings include drilled and tapped base-plate, two hex nuts floating captive in T-slot, or mounting flanges for mounting electromechanical components on either input or output face side of gear train.

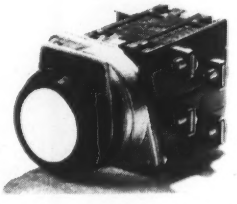
For more data circle MD 14, Page 199

OIL-TIGHT PUSHBUTTONS 16

. . . with removable color identification rings

General Electric Co., Control Dept., Schenectady 5, N. Y.

Designed for machine tool applications, both pushbuttons and multiple-station enclosures are available.



Size: Pushbutton stations, 3$\frac{3}{32}$ in. deep, other dimensions depend on number of stations; ½-in. standard pushbutton extension.

Service: Control of 115, 230, 460 or 575 v ac circuits; coding is simplified with color rings; contacts close with rolling action, maintaining alignment and automatically self-adjusting for wear; enclosures are oiltight.

Design: Single-pole double-throw contact blocks, mounted in pairs with single operator for double-pole double-throw, and tandem combinations with up to 4 normally-open and normally-closed contacts; interchangeable black, red, green, yellow and white color rings; neutral color pushbutton; double-break contacts, with heavy silver overlays; operators include standard, extra-long and mushroom-head pushbuttons, 6 forms of selector switches, 2 combination units, a padlock and a cylinder-lock unit; lightweight aluminum pushbutton station enclosures meet JIC specifications, are available with 1, 2, 3, 4, 6 and 9 stations, and are oil and dusttight.

For more data circle MD 16, Page 199

NEW PARTS

POTTING COMPOUNDS 17

. . . for electric and electronic assemblies

B. G. Forman Co. Inc., 181 *Throop Ave., Brooklyn, N. Y.*

Shrinkage is controlled in these compounds, which polymerize or "set" at elevated or room temperatures.

Designation: Polyform G 107, G 622, G 1230.

Form: Liquid, to which catalyst is added for heat cure, and catalyst plus accelerator for room-temperature cure.

Service: G 107—slight shrinkage, for easy mold extraction and dipping operations; G 622—no shrinkage, for potting transformers in cans; G 1230—slight expansion, for embedding complete units and to adhere to walls of cavity; sets at room temperature in 5 to 15 minutes without fracture; good chemical and aging resistance; heat resistance, 250 F continuous; dimensionally stable; organic or inorganic fillers can be used to increase impact strength.

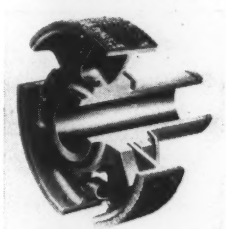
Properties: Thermosetting plastic; low water absorption; good adherence to metals and ceramics; good dielectric properties.

For more data circle MD 17, Page 199

CENTRIFUGAL CLUTCH 18

. . . provides smooth automatic engagement

Elgin Sweeper Co., Clutch Div., 6 *Oak St., Elgin, Ill.*



Outward and rearward movement of the shoes eliminates chatter and gives positive releasing action.

Designation: 100, 200, 300, 400.

Size and Service: Provide large initial torque, since normal speed of motor or engine is reached before load is applied; automatically disengage when engine or motor is idling, or overloads cause stalls or slowdowns below normal operating speeds; engagement speed is adjustable by changing springs; positive release;

Model	Rating (hp)	Pulley Grooves	Pulley Diam (A section, in.)	Pulley Diam (B section, in.)
100	½-3½	1	3.0-5.0	3.4-5.4
200	3-8	1 or 2	3.0-5.6	3.4-6.0
300	6-12	2, 3, 4	3.0-7.0	3.4-7.4
400	12-25	2, 3, 4	4.4-9.0	4.8-9.4

Design: Engagement of drum is made at a predetermined speed when centrifugal force of clutch shoes overcomes tension of clutch springs; engagement is made to rear of direct central impact point, insuring smooth load starting and positive engagement.

For more data circle MD 18, Page 199

PHOSPHATE COATING 19

. . . cleans and coats in one operation

Octagon Processes Inc., 15 *Bank St., Staten Island* 1, *N. Y.*

Two types are available—one for sponge or brush application, the other for immersion.

Designation: Rustclean 12, 15, 151, 152, 153, and 121.

Form: Concentrated liquid for water dilution.

Service: Removes rust, tarnish and light oil, and forms a phosphate base for organic finishes on steel, iron, aluminum, zinc and cadmium; removes tarnish on copper and alloys; Rustclean 12 is for wipe-on application; 15 is for immersion; 151 meets specifications of JAN-C-490, grade 4; 152 meets same, grade 5; 153 meets MIL-C-10578(Ord) Type I; 121 meets same, Type II; special inhibited grades for precision parts remove rust without attack on steel and will prevent hydrogen embrittlement.

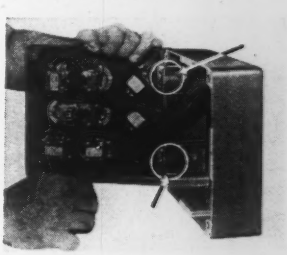
Properties: Contain mild acid with less corrosive action than pickling compounds; no fuming or toxic vapors.

For more data circle MD 19, Page 199

CONTROL STATIONS 20

. . . feature oil-tight hinged cover

Square D Co., 4041 *N. Richards St., Milwaukee* 12, *Wis.*



A sliding internal hinge makes hinged cover construction possible without sacrificing the effectiveness of the oil-tight seal.

Designation: Class 9001, types TY-50, -60, -70, -80.

Size:

Type	No. of Stations	Height (in.)	Width (in.)	Depth (in.)
TY-50	6	8	6¾	$3\frac{13}{16}$
TY-60	9	8	9¼	$3\frac{13}{16}$
TY-70	12	10	9¼	$4\frac{3}{16}$
TY-80	16	10½	11¾	$4\frac{3}{16}$

Service: To facilitate wiring and maintenance of individual pushbuttons, selector switches, key-operated selector switches or pilot lights; cutting oils, coolants, moisture and dust cannot enter; meet NMTBA and JIC standards.

Design: Cast box and cover, mounted on "slide and swing" hinge; composition gasket; finished in blue-gray enamel inside and out; provided with pipe tap at bottom for conduit entry; closing plate assemblies to fit unused holes available; cover can be removed from box; right-hand hinges available on special order.

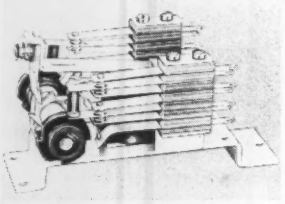
For more data circle MD 20, Page 199

NEW PARTS

RATCHET RELAY 21

. . . with high-speed contact transfer

Potter & Brumfield, Princeton, Ind.



An automatic stop which prevents slippage or overtravel of the ratchet is featured.

Designation: AP.

Size: 4 in. long, 2⅛ in. wide, 2⅛ in. high.

Service: For impulse operation; contacts rated at 5 amp, 115 v ac noninductive load; for up to 230 v ac or dc; contact transfer time as short as 20 millisec; minimum coil breakdown, 500 v rms to core and frame; can be mounted in any position.

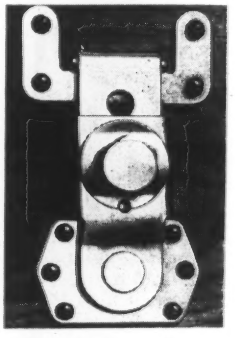
Design: Contact combinations up to 4-pole double throw; contacts are $\frac{3}{16}$-in. diam fine silver; coil is random wound on molded Bakelite bobbin; phenolic cams; hardened-steel ratchet and pawl; pin-hinged balanced armature; tin-dipped solder terminals are standard; available with Bakelite panel and screw terminals, mounted horizontally or vertically.

For more data circle MD 21, Page 199

HEAVY-DUTY LATCH 23

. . . exerts high pulldown pressure

Simmons Fastener Corp., N. Broadway, Albany 1, N. Y.



Providing positive locking without springs, this latch can be used for low-temperature service.

Designation: Link-Lock 1.

Size: 6 in. high in locked position, 2½ in. wide, 1 in. thick max.

Service: For panels, storage containers, cabinets; exerts up to 1500 lb pulldown pressure; carries up to 4000 lb tension loading; withstands temperatures to −70 F; insures watertight sealing when gaskets are used; excellent impact and drop-test resistance; opens or shuts with 90-deg turn of hex nut.

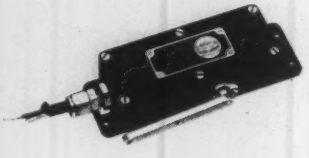
Design: Heat-treated alloy-steel springless construction; engagement latch details can be varied.

For more data circle MD 23, Page 199

ROTARY SWITCH 22

. . . for actuating electric counters

Production Instrument Co. 702-08 W. Jackson Blvd., Chicago 6, Ill.



Although developed for electric counter actuation, this switch is adaptable where electric and mechanical operations must be synchronized.

Designation: ES1A.

Size: 6 in. long, 1⅞ in. wide, $1\frac{9}{16}$ in. deep.

Service: Electric actuation from reciprocal or rotary motion; reciprocal operation requires arm movement of 20 deg min, 340 deg max; in rotary operation switch is closed 140 deg and open 220 deg of each revolution; torque, 2 oz-in. min; arm position is adjustable; rated at 4 amp ac or 2 amp dc for 115 v, 2 amp ac or 1 amp dc for 230 v; max current, 10 amp at 115 v ac, 5 amp at 230 v ac.

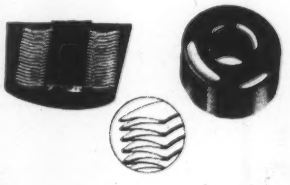
Design: Nickel-silver contact springs with silver points; steel shaft and operating arm; die-cast housing, tapped for conduit; can be furnished with measuring wheels.

For more data circle MD 22, Page 199

STEEL DIAPHRAGM BELLOWS 24

. . . withstand high pressures, temperatures

Breeze Corporations Inc., 41 S. Sixth St., Newark, N. J.



Sizes up to 4 ft OD have been developed, although the conventional size range is under 1 ft OD.

Designation: Bellmets.

Size: To specifications.

Service: As expansion joints, connectors, ducts, or insulation; for fluids or gases; withstand pressures to 500 psi, temperatures to 500 F; tested at 1000 v without flashover between adjacent bellows sections; suppress noise; have been put through 341 million cycles of contraction and expansion without failure, wear or "set" on bellows.

Design: Steel diaphragm sections, formed to special contour, are assembled with alternate welds and plastic bonds; insulating plastic bond is placed at either inner or outer edge of diaphragm so that pressure, either external or internal, serves to reinforce bond.

For more data circle MD 24, Page 199

Load Carrying Capacity

THE AMOUNT of weight or force a given bearing material can successfully support per square inch of its area is known as its load carrying capacity.

In general, the load carrying capacity of a material varies proportionally to its tensile strength and hardness on which basis steel would be an excellent bearing material. However, steel does not possess the low coefficient of friction, conformability and other properties required of a satisfactory bearing material. Thus, our discussion is limited to those metals or alloys which have proven suitable for bearing use, viz; the Babbitts, Copper Lead, Aluminum and Bronzes.

To choose the proper bearing material, many factors must be considered for each particular application. Probably the first decision that must be made is that of how much space can be allotted to the bearing. In some cases there are practically no space limitations, in others the bearing area must be kept at a minimum. Having calculated the projected bearing area—the product of the length of the bearing times its inside diameter—a second design limitation, the maximum force or loading which will be imposed on the bearing at any given instant, must be determined. Often times this process is reversed—with a known maximum load, the bearing area will be partially governed by the size shafting required to transmit the generated force. In either case, with the load and loaded area known, the bearing load per square inch can be found.

The table above indicates the load carrying capacity of the most widely used bearing alloys under varying operating conditions. As can be seen, the maximum loads change 100% or more as operating conditions become more severe. In fact, as the load is doubled, the bearing life is decreased approximately ten times. Normal operation can be described as operation at a moderate range of engine speeds with intermittent stops and starts—average automotive operations. Heavy duty operation means continued high speeds and very heavy loads as obtained in a heavily loaded "high-balling" truck or an automobile operated beyond a reasonable speed. The maximum allowable load, as indicated by the short bearing life, can only be tolerated for short, widely spaced periods of operation.

The distinction is made between the so-called conventional babbitts and the thin babbitts due to the factor of relative fatigue strengths. It has been found that if the babbitt lining materials are held to a .005" maximum thickness, the load at which the bearing material will commence fracturing for a given number of loading cycles will greatly increase. The fatigue phenomenon is best illustrated by the familiar process of breaking a piece of wire by rapidly flexing it back and forth. The internal friction and cold working eventually ruptures the material. In the thin-babbitt linings, the liner follows the flexing action of the steel very closely with less working effort on the material than with the conventional .010"-.020" thickness.

LOAD CARRYING CAPACITY (in lb. per sq. in. of projected bearing area)

MATERIALS	1000 Hours Normal Operation	1000 Hours Heavy Duty Operation	100 Hours Max. Load Allowable
Conventional Babbitts Tin & Lead Base—.016 Thick	1500	1000	2000
Thin Babbitts Tin & Lead Base—.002-.005 Thick	2000	1500	3500
Copper-Lead (SAE 48)	3000	2000	4000
Aluminum Alloys	3500	2500	5500
Overlays Lead or Tin Alloy Plate	4000	2500	7000
Tin Bronzes	5000	3000	7500

Of course, there is some variation from these nominal values within the given classifications, that is as the alloy specification changes. The high lead content babbitts have slightly less strength than the high tin alloys. Similarly, with copper-leads, the softer and weaker lead phase will reduce the load carrying capacity of a 25-30% lead alloy much below that of one with 5-10% lead.

Another important design consideration is that of the oil clearance required by the material. The tendency for copper-lead and aluminum alloys to "Seize" on the shaft requires that a greater space be provided than in the case of the babbitt. The clearance requirement is increased further in the case of the aluminum due to its very high coefficient of thermal expansion. Thus, an application which requires very close running clearances, may have to fall back on babbitts, though the imposed loads would tend to dictate the use of the higher capacity materials.

On the other hand, a relatively low load application operating in or near high heat may force the designer to use aluminum or one of the tin bronzes.

In the case of the overlay bearing—that is a copper-lead bearing material plated with a lead-alloy (.0005"-.002" thick) the load carrying capacity is appreciably increased. The exact manner in which the soft lead alloy affects the increase is not completely understood. However, the results of many tests indicate that the protection afforded the shaft and base bearing material during the critical break-in period is a very important factor. It is felt by many that the distress incurred in the first few hour's running determines the bearing's success or failure. Once the high spots are worn in and the minor misalignments are accommodated, the bearing, if still in good shape, will pile up long hours of successful operation.

The selection of the bearing material to be used cannot be made on the basis of only one desirable property. A tendency to corrode will rule out some materials; low fatigue strength disqualifies others; and the economic factor may prohibit still others. In brief, Load Carrying Capacity, like all the other properties of the various bearing materials, must be considered thoroughly in the light of all the design factors involved in the application at hand.

●

This bearing data sheet is but one of a series. You can get the complete set by writing to—

Johnson Bronze

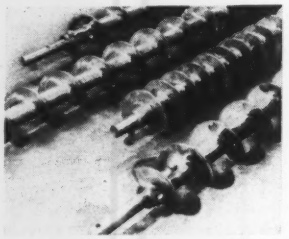
SLEEVE BEARING HEADQUARTERS
525 S. MILL ST. • NEW CASTLE, PENNA.

NEW PARTS

SCREW CONVEYOR 25

. . . has smooth, continuous carrying surface

Kornylack Engineering Corp., 513 *Communipaw Ave., Jersey City* 4, *N. J.*



Available separately, these screws can also be obtained in conjunction with complete conveyor systems.

Size: Standard or special sizes from 1 to 16 in. diam; pitch, thickness and shaft diam to specifications.

Service: As sanitary conveyor; no lap joints or crevices to accumulate dirt.

Design: Joint between flight and pipe of shaft is continuously welded on both sides of flight, ground to a smooth fillet, and polished to a No. 4 finish; flights are uniformly thick from pipe to outer edge; available in stainless steel, monel, aluminum or other metals.

For more data circle MD 25, Page 199

SYNTHETIC O-RINGS 27

. . . have high fuel resistance

Parker Appliance Co., 17325 *Euclid Ave., Cleveland* 12, *O.*

In the presence of hydrocarbon fuels this material undergoes 20% less volume change than any heretofore developed.

Designation: Compound 1009-10.

Size: Dynamic-seal series—88 standard sizes from $\frac{1}{16}$ to $\frac{1}{4}$-in. ring width, $\frac{1}{4}$ to 16 in. OD; static-seal series—$\frac{1}{8}$-in. ring width, $1\frac{7}{8}$ to $10\frac{1}{4}$ in. OD; special sizes and molded shapes available.

Service: Has low swell in presence of hydrocarbon fuels at temperatures to −65 F; bending moment of only 0.75-lb-in. at −70 F; test results after 24-hr immersion in types I, II and III of MIL-H-3136 fluid at room temperature as follows;

Property	Before Immersion	MIL-H-3136 I	MIL-H-3136 II	MIL-H-3136 III
Hardness, Shore A (deg)	70	69	60	59
Tensile strength (psi)	1500	1336	938	1119
Elongation (%)	200	195	180	185
Volume increase (%)	...	3.1	33.8	26.5

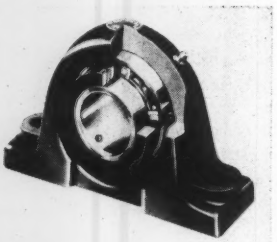
Design: Molded from synthetic rubber compound.

For more data circle MD 27, Page 199

PILLOW BLOCK 26

. . . has low-friction seal wiping action

SKF Industries Inc., Philadelphia 32, *Pa.*



Infrequent lubrication is required, reducing maintenance costs.

Designation: Hess-Bright SY.

Size: For shaft diam from $1\frac{3}{16}$ to $2\frac{15}{16}$ in.

Service: Low-friction wiping action of seal against inner bearing ring; interchangeable with existing installations; prevents dirt contamination.

Design: Ball-bearing pillow block with lubricant-retaining Du Pont Fairprene red seal; rotating flingers exclude dirt; spherical outer ring compensates for initial misalignment; Alemite fitting for relubrication.

Application: Conveying, agricultural, chemical, food, ginning and textile machinery; light fans and blowers; light power take-off units.

For more data circle MD 26, Page 199

PLASTIC PIPE 28

. . . for water, high vacuum or pressure

Carlon Products Corp., 10225 *Meech Ave., Cleveland* 5, *O.*

Similar to the company's EF flexible pipe, this new type has increased wall thickness for protection against burst or collapse.

Designation: WS.

Size:

Nominal (in.)	OD (in.)	ID (in.)	Weight (lb per ft)	Length (ft)
$\frac{3}{4}$	1.170	0.824	0.216	400
1	1.433	1.070	0.285	300
$1\frac{1}{4}$	1.850	1.380	0.477	300
$1\frac{1}{2}$	2.260	1.610	0.790	250
2	3.000	2.070	1.88	200
2	2.495	2.070	0.62	200
$2\frac{1}{2}$	2.950	2.470	0.82	150
3	3.670	3.070	1.28	100
4	4.820	4.030	2.20	25
6	7.260	6.070	5.00	25

* Coils, except nominal 4 and 6-in. sizes in straight lengths.

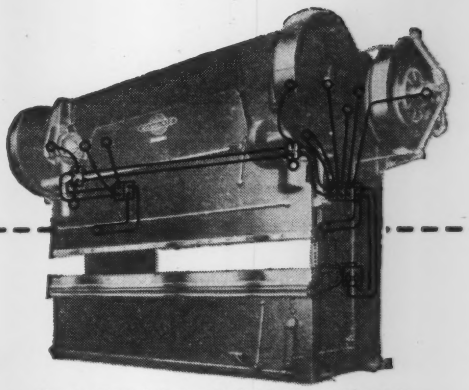
Service: Water service, vacuum or pressure with working pressure to 120 psi at 120 F in sizes to 2 in. (3.000 in. OD), 75 psi at 120 F in sizes from 2 in. (2.495 OD) to 6 in.; resists rot, rust and electrolytic corrosion; smooth internal surface will not accumulate scale or sediment.

Design: Smooth-wall flexible plastic; plastic-to-plastic or plastic-to-metal connections made with molded plastic fittings.

For more data circle MD 28, Page 199

Designed!

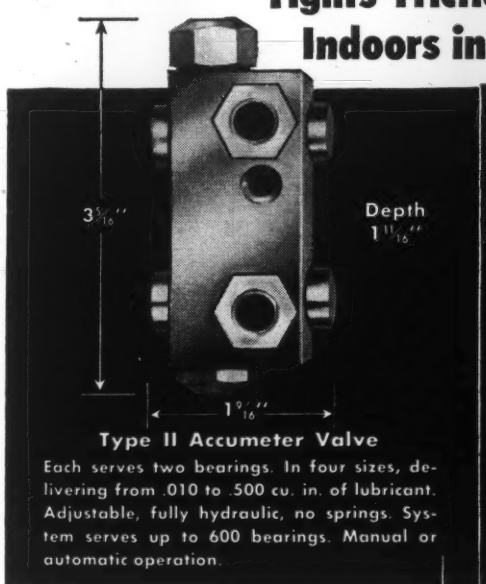
to increase machine hours
...reduce man hours



Alemite Type II Accumeter lubricates all 13 points simultaneously on Press Brakes manufactured by Doelger & Kirsten, Inc., Milwaukee, Wisconsin.

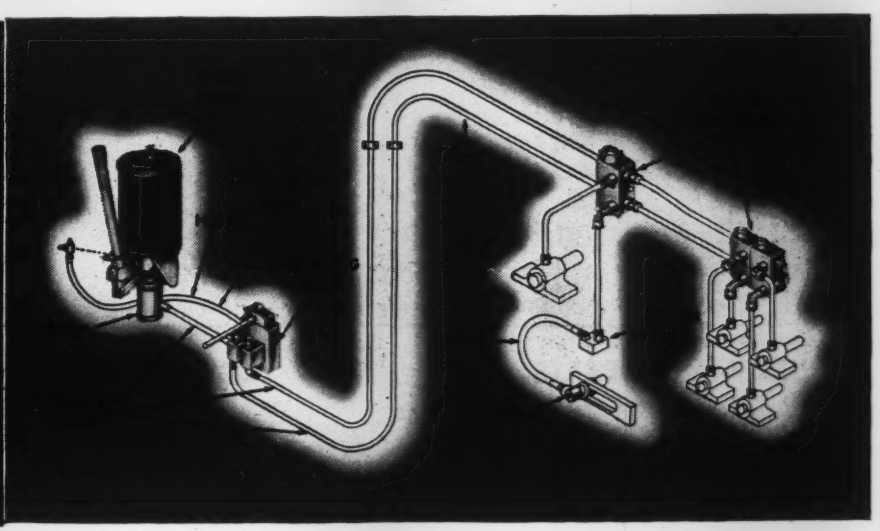
ALEMITE Accumeter AUTOMATIC LUBRICATION

Fights Friction Everywhere...Outdoors in Any Weather Indoors in Grit-Laden Air or Heavy Industrial Fumes



Type II Accumeter Valve

Each serves two bearings. In four sizes, delivering from .010 to .500 cu. in. of lubricant. Adjustable, fully hydraulic, no springs. System serves up to 600 bearings. Manual or automatic operation.



brings all these advantages!

- Eliminates shutdown time for lubrication. *Adds* productive time to machine output.
- Seals completely against dirt, grit, water all the way from "Barrel-to-Bearing."
- Prevents bearing troubles due to neglect or use of wrong lubricant.
- Services *all* bearings—including those inaccessible or dangerous—in one operation.
- Avoids work spoilage and bearing repairs due to over-lubrication.

Factory-Tested . . . Field-Proved!

Exhaustive tests showed *no variation* in the amount of lubricant discharged . . . even after 73,312 lubrication cycles, *equal to 122 years of twice-a-day service.* Proved in the field, where one big-plant installation reduced lubrication costs $3,527 in only 65 days!

For Tough-Job Lubrication of Heaviest Machines!

From one central point, Alemite Accumeter Lubrication System delivers the exact, measured amount of oil or grease to *all* bearings of a machine. In seconds—in a fraction of the time required for hand lubrication—Accumeter *automatically* measures and delivers lubricant . . . *while the machine is in operation.* No downtime for lubrication . . . no points missed!

Type II Accumeter cuts costs, boosts production under conditions that would render other systems inoperative. It is unaffected by gritty, highly abrasive atmosphere—*because it is fully sealed and enclosed!* Operates in salt spray, severe acid or fume conditions, even totally immersed—*because it may be painted or treated with non-corrosives.* For all extremes of weather or temperature—from sub-zero to 200°F.

Adds years of productive time to the heaviest machines. Type II Accumeter can serve groups of machines and will handle every oil or grease that can be pumped. It is just one of three types of Accumeter systems. One of them will serve *your* requirements!

SEND NOW for your free copy of this new Alemite Accumeter Catalog and Engineering Data Book. Address: Alemite, Dept. R-62, 1850 Diversey Parkway, Chicago 14, Ill.

A PRODUCT OF SW STEWART WARNER

ALEMITE

REG. U.S. PAT. OFF.

NEW PARTS

COPPER-SILVER ALLOY 29

. . . has high electrical conductivity

Handy & Harman, 82 Fulton St., New York 38, N. Y.

This alloy is especially suitable for spring parts requiring high electrical conductivity and high strength.

Form: Round or flat wire.

Size: Round wire, 0.016-in. diam or finer; flat wire of equivalent cross-section area with maximum width of ½-in.

Service: Electric conductivity, 70% (International Annealed Copper Standard); tensile strength, 140,000 to 165,000 psi; shears cleanly; cuts freely to fine finish; sufficient ductility to withstand some forming.

Properties: Alloy containing 94% copper, 6% silver; supplied in heat-treated and cold-worked condition.

Applications: Instruments, watches, electric controls and accessories.

For more data circle MD 29, Page 199

WELD-THROUGH SEALER 31

. . . applied to joints before spotwelding

Minnesota Mining and Mfg. Co., 411 Piquette Ave., Detroit 2, Mich.

Uniformly squeezing away from the bottom weld when electrode pressure is applied, this sealer does not interfere with the welding operation.

Designation: EC-1168.

Form: Heavy paste.

Service: Water and weathertight flexible sealing between faying surfaces; applied to full width of seam; resists heat and pressure of welding without splattering and burning; does not alter normal welding procedure or weld quality; adheres well to steel, aluminum and other metals; will not flow or separate out at sustained temperatures to 475 F; remains pliable to −10 F; applied with hand caulking gun or pressure extruding equipment.

Properties: Aluminum colored hydrocarbon base with petroleum naphtha solvent; solids content, 91% by weight; viscosity, 18-25 on No. 18 MacMichael wire.

For more data circle MD 31, Page 199

RUBBER-METAL PARTS 30

. . . fabricated to specifications

Andrews-Alderfer Co., 1090 Home Ave., Akron 10, O.

Rubber shapes are bonded to any ferrous or nonferrous metal, or to various ceramic compositions.

Size: Custom-fabricated to specifications.

Service: Rubber stocks available with tensile strengths ranging from 500 to 3500 psi, durometer hardnesses from 30 to 100, elongation from 50 to 900%, temperature resistance from −75 to 200 F; abrasion, weather and chemical-resistant stocks may be utilized.

Design: Molded-rubber shapes fabricated from natural or reclaimed rubber, or synthetics such as Buna S, Buna N, neoprene, butyl or Thiokol; parts of metal or various ceramics can be molded-in or bonded.

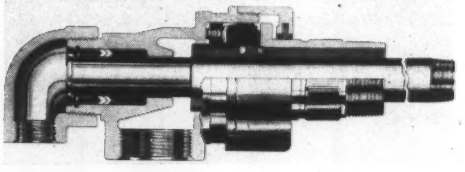
Application: Control valves; conveyors; electric switches, contacts, controllers and control devices.

For more data circle MD 30, Page 199

REVOLVING JOINT 32

. . . compensates for all misalignment

Rotherm Engineering Co. Inc., 4911 W. Irving Park Rd., Chicago 41, Ill.



This design permits the rotor to find its own center of rotation.

Size: ½ to 5-in. pipe size.

Service: Handles steam, air, oil, gas and other liquids at pressures up to 300 psi; large temperature range; compensates for roll eccentricity, piping misalignment and roll end-play.

Design: Stationary or rotating siphon; rotor turns against flat face of a nonporous carbon disk; opposite face of disk is spherical in shape and bears against a ball seat, allowing for misalignment; inside of casing is sealed by a spring-seated Teflon wedge seal that acts as expansion joint; wearing surfaces are ground and chrome plated for hardness; for solid piping, or with flexible hose by changing nut and rotor.

For more data circle MD 32, Page 199

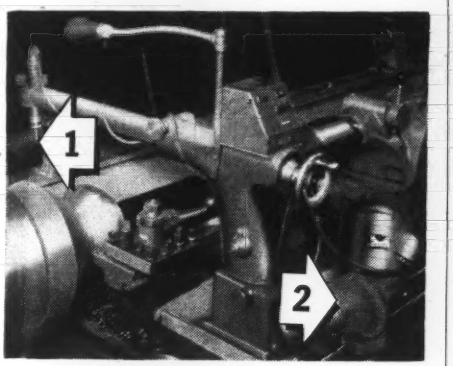
Electronic Duplicator Greatly Increases Machine Tool Output

Increase in production rates of as much as 600% have been reported from the use of the VOSS-RAYTHEON Electronic Duplicators in conjunction with lathes or other equipment for all types of turning and boring operations.

The Duplicator produces a rapid, accurate means of duplicating even extremely difficult contours, without the constant attention of a skilled operator.

Method of Operation

The illustration below shows the Duplicator applied to an engine lathe. A stylus (1) traces the contours of



a template conforming to the shape to which the work is to be machined. Motion of this stylus transmits a signal to the electronic control unit. The signal depends on the curves or turns made by the stylus, and on lateral, longitudinal or diagonal pressure.

Gearmotor Drives Compound or Cross Slide

The electronic control unit, in turn, governs the operation of a Star-Kimble Gearmotor (2), which drives the compound or cross slide. This Gearmotor is an integrally designed right-angle unit with an aluminum housing. For precise duplication the Gearmotor is designed to provide 300 revolutions for 1 inch of cutting tool movement.

For other applications requiring speed reduction, Star-Kimble supplies Gearmotors with a wide choice of speed ratios ranging from 2.5:1 to 97:1. All sizes and types are designed with an extra margin of safety for handling overloads. All Star-Kimble Gearmotors meet AGMA specifications.

Information on Gearmotor ratings and features is contained in Bulletin B-601, available on request from Star-Kimble Motor Division of Miehle Printing Press and Mfg. Co., 201 Bloomfield Avenue, Bloomfield, New Jersey.

Advertisement

PLANETARY DRIVE REDUCES WEAR... LENGTHENS LIFE of Star-Kimble Gearmotors

THE planetary gear speed-reducing system used and proved for a quarter of a century in Star-Kimble Gearmotors distributes the bearing load uniformly and reduces the risk of wear.

Helical gears of the planetary system are precision-shaved in Star-Kimble's own plants for the continuous tooth contact that assures quiet operation and long life.

Moving parts within the sturdy reducer housing maintain a constant fine spray of lubricant from an oil reservoir to the bearings and gears. Oil seals prevent leakage.

Tapered roller bearings on output shaft eliminate end play—allow Gearmotor to be mounted in any position.

Most important advantage of all is the fact that every Star-Kimble Gearmotor is an integrally designed, integrally built unit. All parts are Star-Kimble engineered to work smoothly and efficiently together—all motors, gears and other major components are produced by Star-Kimble.

*Demanded by industry for tough start-and-stop jobs.

For the facts on Star-Kimble Gearmotors, write for a copy of Bulletin B-601.

STAR-KIMBLE

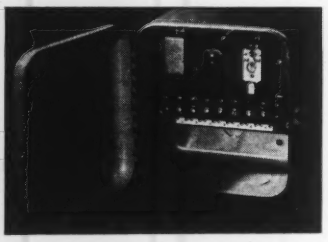
MOTOR DIVISION OF
MIEHLE PRINTING PRESS AND MFG. CO.
201 Bloomfield Avenue Bloomfield, New Jersey

NEW PARTS

PILOT RELAY 33

. . . has 2.5-million current amplification

Haledy Electronics Co., 57 *Williams St., New York, N. Y.*



Delicate mechanisms with light contact pressures and small current flows can control relatively large operating currents.

Designation: SS.

Size: 7-in. high, 6-in. wide, 4-in. deep; weight, 3 lb 2 oz.

Service: Operates on current flow of 2 microamp; relay contacts rated 5 amp at 115 v ac; operates over any input resistance from dead short to 10 megohm; power consumption, 2 w at 115 v, 60 cycles (other voltages and frequencies to order); unlimited lead length; requires no warm-up.

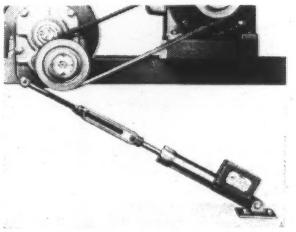
Design: Electronic with cold-cathode triode tube; SPDT relay contacts; 18-gage drawn steel case, finished in gray wrinkle; case can be locked; visible jewel indicator indicates on-off operation.

For more data circle MD 33, Page 199

OVERLOAD RELEASE 35

. . . for torque-arm speed reducers

Dodge Mfg. Corp., Mishawaka, Ind.



Affording triple protection, this release loosens the belt, cuts off the current and activates a warning device.

Designation: Tri-Matic.

Size: Lengths, 24 in. min adjustable to 30 in. max; 27 to 33 in.; or 29 to 35 in.

Service: Preventing excessive load on equipment; calibrated for adjustment to load conditions up to maximum capacity; acts instantly and positively; manually pulling speed reducer back into position automatically cocks overload-release mechanism.

Design: Pressure exerted by overload causes piston to move lengthwise through the unit, loosening the belt; movement activates a MicroSwitch which cuts off current and activates a warning bell, siren or light.

For more data circle MD 35, Page 199

DIAL INDICATOR 34

. . . for temperature, pressure or loads

Taylor Instrument Cos., 95 *Ames St., Rochester* 1, *N. Y.*

Available in several mounting styles, this indicator is well suited for either panel or individual mounting.

Size: 6 in. dial; 7¼ in. OD, $3\frac{7}{16}$ in. thick.

Service: Pressure or temperature indication; temperature ranges from −100 F to +1200 F with mercury, vapor, gas or organic-liquid actuation; pressures from 12 psi to 20,000 psi; tension or compression load elements can be incorporated for load applications from 0 to 75,000 lb.

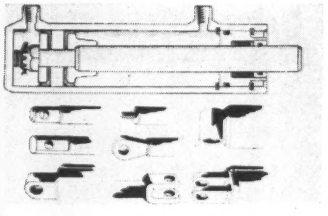
Design: Bourdon spring actuation; white graduations on black background with white wedge-shaped pointer provided with microadjustment for zero setting; stainless-steel movement; die-cast aluminum case for face or flush mounting; thermometer connections may be adjustable angle rigid, rigid back or bottom stem to case, or capillary; pressure connections may be back or bottom; bezel mounted in case with breech lock threads requiring less than ¼-in. turn for engagement; glass is held against recessed rubber O-ring to provide moistureproof seal.

For more data circle MD 34, Page 199

HYDRAULIC CYLINDERS 36

. . . built around simple basic design

Unit Mfg. Co., 1221 *Harmon Place, Minneapolis* 3, *Minn.*



These cylinders can be obtained on orders of 25 or more, with unusual or special designs also available to specifications.

Size: ½-in. to 60-in. strokes; 1, 1½, 2, 2½, 3 or 3½ in. cylinder ID.

Service: For hydraulic systems; output capacities range from 392 lb at 500 psi for smallest unit to 19,242 lb at 2000 psi for largest; reliable service due to simplified construction.

Design: Double-acting, with cup and chevron packing; single-acting, with O-ring seals; all-welded construction, with precision ground and honed parts; seamless steel tubing cylinder case; choice of 6 clevises or pivots for rod and case ends.

For more data circle MD 36, Page 199

School Daze!

Just because that bathing suit is proper at the beach, she shouldn't assume it's proper for the classroom, too!

And just because one bearing is best lubricated by one particular grade of oil, you shouldn't assume that the same oil is best for *all* bearings on that machine. In many cases it isn't.

OIL CUPS permit you to lubricate each bearing with the oil best suited to that bearing—thus prolonging bearing life, reducing maintenance costs, cutting down-time, boosting production. And oil cups fortunately *cost very little.*

Gits oil cups have been the standard for industry for more than 40 years. Gits Bros. has the largest selection of oil cups available anywhere. Call on Gits Bros. for a prompt, efficient solution to your lubrication problems.

Write for free Catalog No. 60-A

GITS BROS. MFG. CO.

1868 S. Kilbourn Ave. • Chicago 23, Illinois

NEW PARTS AND MATERIALS

STYRENE PLASTIC 37

. . . retains strength at low temperatures

United States Rubber Co., Naugatuck Chemical Div., Rockefeller Center, New York 20, *N. Y.*

Toughness and high impact strength are retained by this thermoplastic molding and extruding compound at temperatures to −60 F.

Designation: Kralastic J.

Form: Fine powder for mill or banbury mixing, or molding or extrusion granule.

Service: Low-temperature applications where high impact strength and toughness is required; tensile strength, 3100 psi; flexural modulus, 140,000 psi; flexural strength, 5400 psi; Rockwell hardness (R scale), 62-65; impact strength, 6 to 7 ft-lb per in. notch at 25 C, 5.5 at 0 C, 6.0 at −10 C and −20 C, 5.8 at −30 C, 5.2 at −40 C; resists acids, alkalies and salts; soluble in ketones and aromatics; swells in aliphatics; volume resistivity, 0.054 × 10^{14} ohm-cm at 25 C; dielectric strength, 340 v per mil; electrical properties as follows;

	60 cycles	1000 cycles	10^6 cycles	3×10^9 cycles
Dielectric constant	4.00	4.47	4.05	2.80
Power factor	0.0107	0.0023	0.0178	0.0075
Loss factor	0.0427	0.0102	0.072	0.021

Properties: Styrene copolymer; thermoplastic; specific gravity, 1.015; heat distortion (2 C per min, 264 psi), 170 F; water absorption (24 hr), 0.3-0.4.

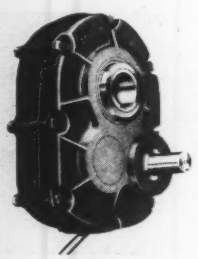
For more data circle MD 37, Page 199

SHAFT-MOUNTED SPEED REDUCER 38

. . . has large horsepower capacity

Dodge Mfg. Corp., Mishawaka, Ind.

Horsepower capacity has been increased 59% over the largest previously available model.



Designation: No. 7.

Size: Height, 25¾ in.; width, 18½ in.; thickness, 10 in.; 4⅜ in. driving shaft extension; weight, 400 lb.

Service: For output speeds from 12 to 110 rpm; gear reduction ratio, 14.97 to 1; turnbuckle provides easy adjustment of belt tension; horsepower ratings as follows;

Output Speed (rpm)	Rating (hp)	Output Speed (rpm)	Rating (hp)
12	6.5	60	27.0
15	8.1	70	30.3
20	11.1	80	33.4
30	16.1	90	36.6
40	20.4	100	39.7
50	23.9	110	42.8

Design: Double-reduction, shaft-mounted; anchored with torque arm which fastens to any fixed object; backstop available.

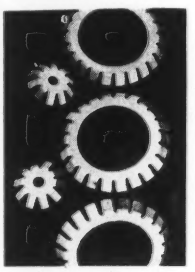
For more data circle MD 38, Page 199

CUP EXPANDERS 39

. . . increase efficiency of cylinder packings

HPL Mfg. Co., 15189 *Miles Ave., Cleveland* 28, *O.*

Controlled pressure is exerted on the cup-packing lip to maintain constant contact.



Designation: ES-11.

Size: For standard hydraulic and pneumatic packing diameters from 1¼ to 2⅞ in.

Service: Insuring positive sealing action of cup packing; increase effective packing life and decrease leakage due to shrinkage of packing; do not increase friction or wear since pressure is only great enough to support the packing; not affected by brine, gasoline or alcohol.

Design: Fabricated from 0.010-in. specially rolled strip brass.

Application: Pumps, compressors, hydraulic presses, jacks, air cylinders, feed mechanisms, lubricators.

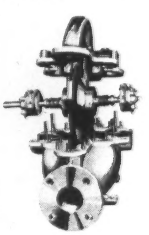
For more data circle MD 39, Page 199

CENTRIFUGAL PUMP 40

. . . half as wide as conventional pumps

Peerless Pump Div., Food Machinery and Chemical Corp., 301 *West Ave.* 26, *Los Angeles* 31, *Calif.*

Use of mechanical shaft seals instead of packing results in shorter shafts, reducing deflection and saving floor space.



Designation: AS.

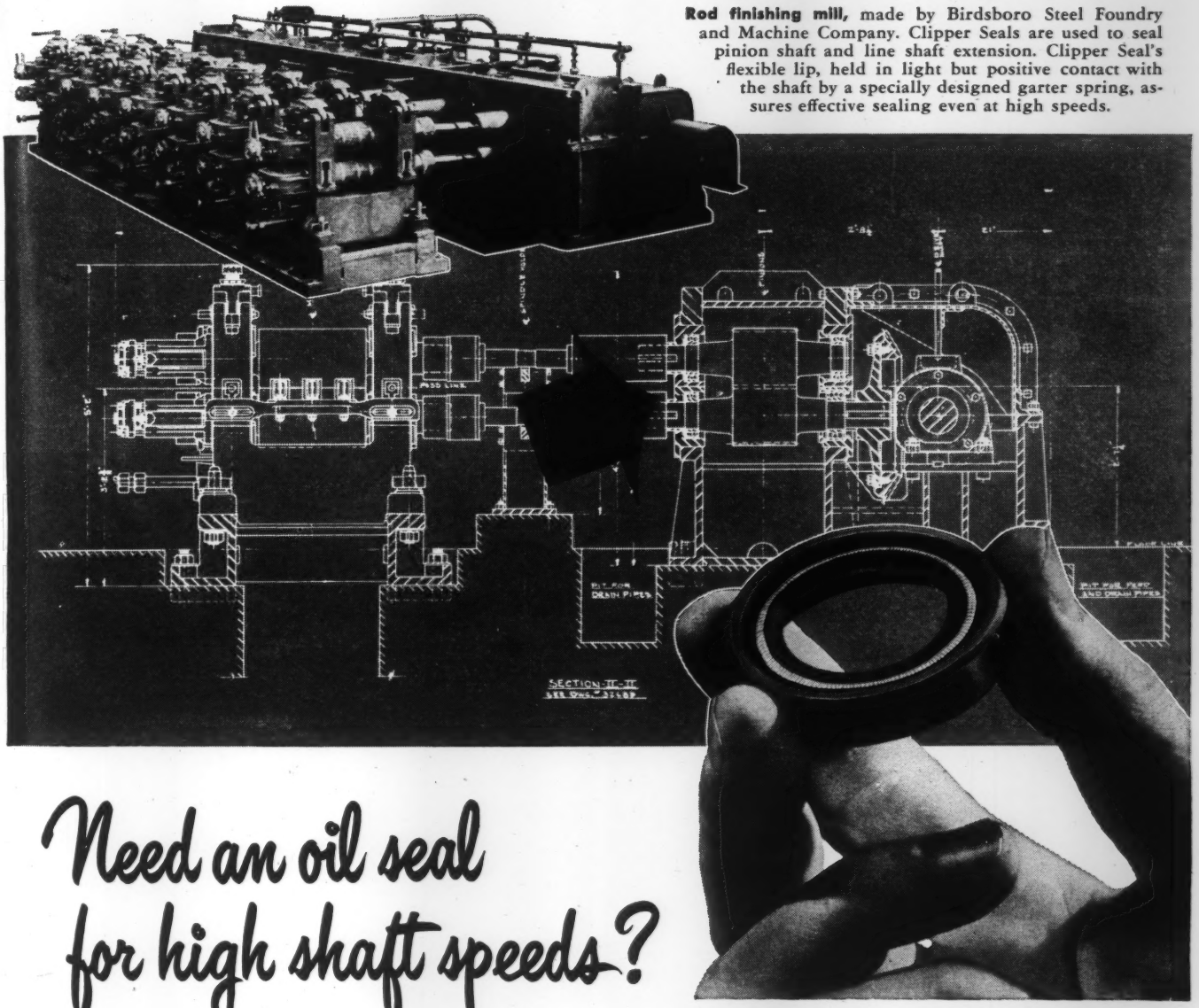
Size:

Intake (diam, in.)	Discharge (diam, in.)	Length (in.)	Width (in.)	Height (in., approx)
2	1½	13¼	15	17
3	2	16¾	16	18
3	2½	19	18	21
4	3	21	17½	22
5	4	23	19¾	23½

Service: Capacities to 750 gpm; heads to 230 ft; handles liquids to 200 F where no solids are in suspension; long life since shaft deflection is small; seal repacking not necessary; easily serviced.

Design: Horizontal split-case, with mechanical shaft seals; split is at centerline of pump shaft, allowing upper case and rotating element to be removed without disturbing piping connections or alignment; available with electric-motor, gasoline-engine or steam-turbine drive mounted on common base; bronze impellers are enclosed double-suction design; cast-iron, stainless, Monel or other alloy impellers available; grease-lubricated ball bearings; bronze wearing rings.

For more data circle MD 40, Page 199



Rod finishing mill, made by Birdsboro Steel Foundry and Machine Company. Clipper Seals are used to seal pinion shaft and line shaft extension. Clipper Seal's flexible lip, held in light but positive contact with the shaft by a specially designed garter spring, assures effective sealing even at high speeds.

Need an oil seal for high shaft speeds?

Birdsboro chose Clipper Seals

The Birdsboro 8-stand finishing train shown above is expected to operate around the clock, day in and day out. And since it is to be part of a large, high-speed, steel rod producing unit, Birdsboro designed it to be as maintenance-free as possible.

In order to minimize down time, particular attention was paid to bearing design and lubrication. The mill stands are equipped with open, water-lubricated bearings. Because of high shaft speeds, bearings in the combination spiral bevel gear reduction and pinion stand are anti-friction in type, lubricated with circulating oil, and sealed with Clipper Seals.

Birdsboro engineers chose Clipper Seals for this application because of their outstanding ability to withstand the heat of friction generated by high shaft speeds . . . and their ability to make a tight and lasting seal against the circulating bearing lubricant.

Still other reasons for Birdsboro's preference for Clipper Seals: They are precision-molded, compact in design, and exceptionally easy to install. They may be removed and replaced without impairing their sealing efficiency. And because of their unique design, Clipper Seals cause a minimum of shaft wear.

Precision-molded Clipper Seals are made in a variety of designs to meet almost any sealing condition. They are available in split and endless types, with a choice of heel and lip combinations for various services. For details, write for Brochure PK-46A. Address, Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville CLIPPER SEALS

ENGINEERING DEPARTMENT

EQUIPMENT

For additional information on this new equipment, see Page 199

SNAP-ON EXTENSOMETERS 41

. . . have adjustable high magnification

Tinius Olsen Testing Machine Co., Easton Rd., Willow Grove, Pa.

Three magnifications, all instantly available by switching, are engraved on each instrument.

Designation: S-1, S-2, S-3, S-4, S-5, S-8.

Size: Average weight, 7½ oz.

Type	Gage Length (in.)	Flats & Rounds (in.)	Magnification
S-1*	2	1/16 - 5/8	250, 500, 1000
S-2*	2	1/16 - 5/8	100, 200, 400
S-3	1	1/16 - 3/8	125, 250, 500
S-4	1	1/16 - 3/8	50, 100, 200
S-5	1.4	1/16 - 3/8	125, 250, 500
S-8	8	1/16 - 1½	250, 500, 1000

*Also available: sheet metal attachment; Models S-1-1, S-2-1 for specimens up to 1 in.; Models S-1-2, S-2-2 for specimens up to 2 in.

Service: For elastic and plastic tension testing; registers strain on drum type recorder.

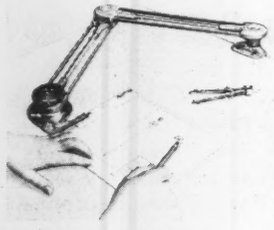
Design: Stretching of specimen moves core of differential transformer; ac voltage created runs recorder drum motor in direct proportion to strain; clamps on with hand pressure; backlash eliminators built in; dustproof case and polarized plug.

For more data circle MD 41, Page 199

DRAFTING MACHINE 42

. . . small edition of standard unit

V. & E. Mfg. Co., 758 S. Fair Oaks Ave., Pasadena 20, Calif.



Having high accuracy for detail work, this drafting machine is rugged and low in cost.

Designation: Vemco 33.

Size: Arms, 16 in. long; for 24 x 36-in. board.

Service: For small-size drawings; arms are articulated so scales lie flat; band tension is easily adjustable; protractor reads to 1 deg and to 10 min with double vernier; all angles are set by protractor brake, including 15-deg positions; protractor scales can be rotated on arm, giving full-circle base-line setting.

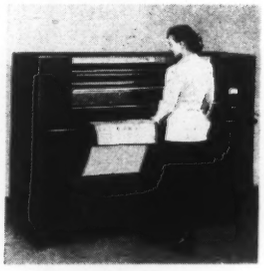
Design: Spring-steel bands in zinc-coated steel covers run over anodized aluminum-alloy pulleys whose critical dimensions are turned with a diamond point for accuracy; resilient scale sockets, permitting easy removal; chrome-plated steel tubular arms with ball joint in brackets; duraluminum protractor, vernier and scale arm; plastic central skid button on drafting head.

For more data circle MD 42, Page 199

COPYING MACHINE 43

. . . for moderate print requirements

Charles Bruning Co. Inc., 125 North St., Teterboro, N. J.



High speed is possible with this low-cost machine.

Designation: Copyflex 30.

Size: 46 in. printing width; handles standard 42 in. roll.

Service: For making black on white prints from translucent originals; handles roll stock or multiple cut sheets of sensitized paper, acetate-coated paper, film or cloth at rates to 12 ft per min; oversize lamp helps insure uniform exposure; connects to 230 v, 60 cycle ac line—50 cycle models available.

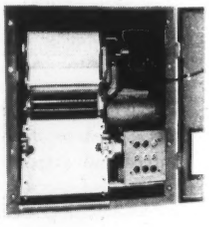
Design: White printer with 2000 w, 48-in. mercury arc lamp; two controls—for on-off operation, and for printing-speed control.

For more data circle MD 43, Page 199

HIGH-SPEED RECORDER 44

. . . provides uniform printed data

ANelex Corp., Concord, N. H.



Developed originally for analog or digital computers, this recorder may be used wherever data is available in electric or mechanical form.

Designation: Synchroprinter.

Size: Case, 19 in. wide, 15 in. deep, 24 in. high; handles 500 ft roll of 8½ in. wide paper.

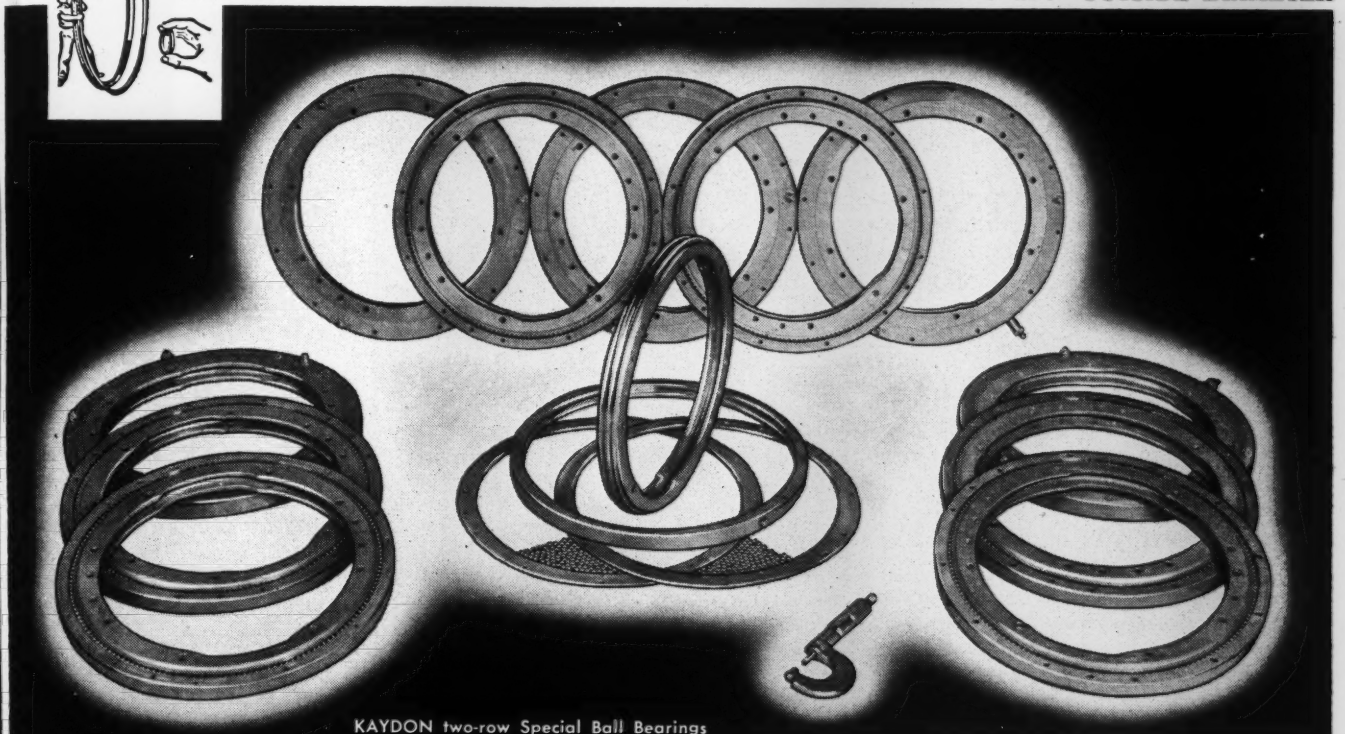
Service: Prints 40 characters per line, 15 lines per second—a total of 600 characters per second; simultaneous decimal printing of 40 channels or sequential printing from one channel on one line; intermittent data can be consolidated in uniform lines.

Design: Motor drives print roll and two synchronizing pulse generators; synchronizing pulses actuate triggering circuits causing magnetically operated hammers to imprint paper with digits from print roll; synchronous generators also time rotation of print roll, determine beginning of printing cycle, advance paper, and control auxiliary equipment; digit alignment, ±1/32 in.; power input, 10 amp at 6.3 v ac or 150 ma at 300 v dc.

For more data circle MD 44, Page 199

Contact KAYDON of Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER



KAYDON two-row Special Ball Bearings
8.062" x 10.687" x .750"

Dependable Life-Savers ...KAYDON-bearinged Piasecki HELICOPTERS

CONTROL movements of Piasecki HUP Helicopters . . . life-savers of the air . . . are transmitted to the spinning rotor blade assemblies by means of a swash plate that moves on unique two-row KAYDON Special Ball Bearings.

Control of the helicopter is obtained by the movement of its rotor blades. Each blade can move in six different directions while they are rotating. Thus the mechanism responsible for control movements is complex, important, and it demands the utmost in bearing-precision.

KAYDON met the challenge of this intricate bearing-problem with these special two-row, thin section, 8.062" x 10.687" x .750" ball bearings. Similarly, KAYDON cooperates with designers of many types of precision equipment to achieve their objectives.

KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust • Roller Radial • Roller Thrust • Bi-Angular Bearings

THE KAYDON ENGINEERING CORP.

MUSKEGON • MICHIGAN

PRECISION BALL AND ROLLER BEARINGS

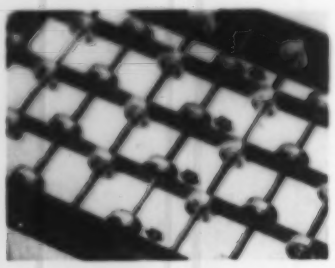
NEW PARTS AND MATERIALS

WHEEL CONVEYOR 5

. . . reinforced for extra strength

Rapids-Standard Co. Inc., Dept. IR8, 342 Rapistan Bldg., Grand Rapids 2, Mich.

Bulky roller conveyors can be replaced by this heavy-duty wheel conveyor.



Designation: Industrial Rapid-Wheel.

Size: 5 and 10-ft sections, 12 and 18-in. wide; 45 and 90-deg curves.

Service: Heavy-duty conveying with distributed load of 1 ton over 5-ft section possible.

Design: Multiple-wheel; 3½-in. deep channel frames of 12-gage steel; each lane of wheels is reinforced with steel center band which supports axles at points of greatest strain; available with tubular or channel-type guard rails, or may be used without guard rails.

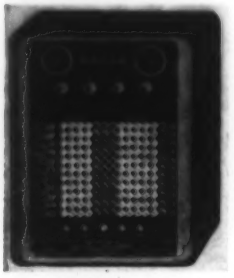
For more data circle MD 5, Page 199

OPERATIONS PRESELECTOR 7

. . . adjusts timing of multiple operations

Henry G. Dietz Co., Coral Designs Div., 12-16 Astoria Blvd., Long Island City 2, N. Y.

Shown is a unit for laundry machinery, which controls the temperature, time and water level for each of 11 wash cycles.



Designation: 125.

Size: Depends on design.

Service: Adjusts timing of each cycle independently; can energize a number of circuits during a single cycle; duration of one cycle can be changed without affecting others; available for ac or dc.

Design: Synchronous motor timer delivers a repetitious fixed-time impulse; multiples of this impulse are preselected with pushbuttons to control duration of individual cycle; custom built from standard parts; cycle progress can be shown with pilot lights; cabinets to provide dustproof and steam-tight housing available.

For more data circle MD 7, Page 199

TEMPERATURE CONTROLLER 6

. . . provides straight-line control

Minneapolis-Honeywell Regulator Co., Brown Instruments Div., Wayne & Windrim Aves., Philadelphia 44, Pa.

Close control is obtained on equipment where rapid heating rates, small heating capacity or abnormal lags are encountered.

Designation: Pulse Pyr-O-Vane.

Size: 6-in. indicating scale.

Service: Control of electrically heated or fuel-fired equipment; variable proportional band between 1% and 3% of full scale; periodic load relay actuation to suit requirements with cycle times of 3, 7.5, 12, 18, 30 or 72 sec; available for 115 v, 25 or 60 cycles ac, or 230 v, 50 or 60 cycles ac; relay contact rating, 5 amp.

Design: Time-proportioning indicating millivoltmeter controller; time-proportioning control unit consists of oscillator, amplifier and relay, with additional gear train, synchronous motor, eccentric aluminum vane and set of oscillator coils; calibrated adjustment changes proportional band setting; set of 16 change-gears vary cycle time; signal lamps in front of flush or surface-mounted case indicate control-unit relay operation; plug-in galvanometer and control units.

Application: Vacuum plastic molding equipment, plastic extruders, nylon heat-setting equipment.

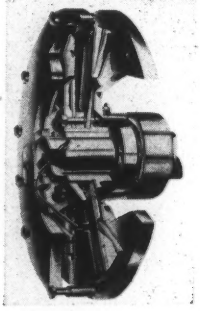
For more data circle MD 6, Page 199

AIR-OPERATED CLUTCH 8

. . . for heavy duty applications

Cardwell Mfg. Co. Inc., Clutch Div., P.O. Drawer 2001, Wichita, Kans.

Shaft space is claimed to be 20% less than the shortest clutch of any other design.



Designation: Flex-Disc.

Size and Service: Requires no adjustment; long friction-surface life due to uniform plate pressures and air-cooled operation; maximum torque capacity at point of slip with 80 psi air pressure as follows:

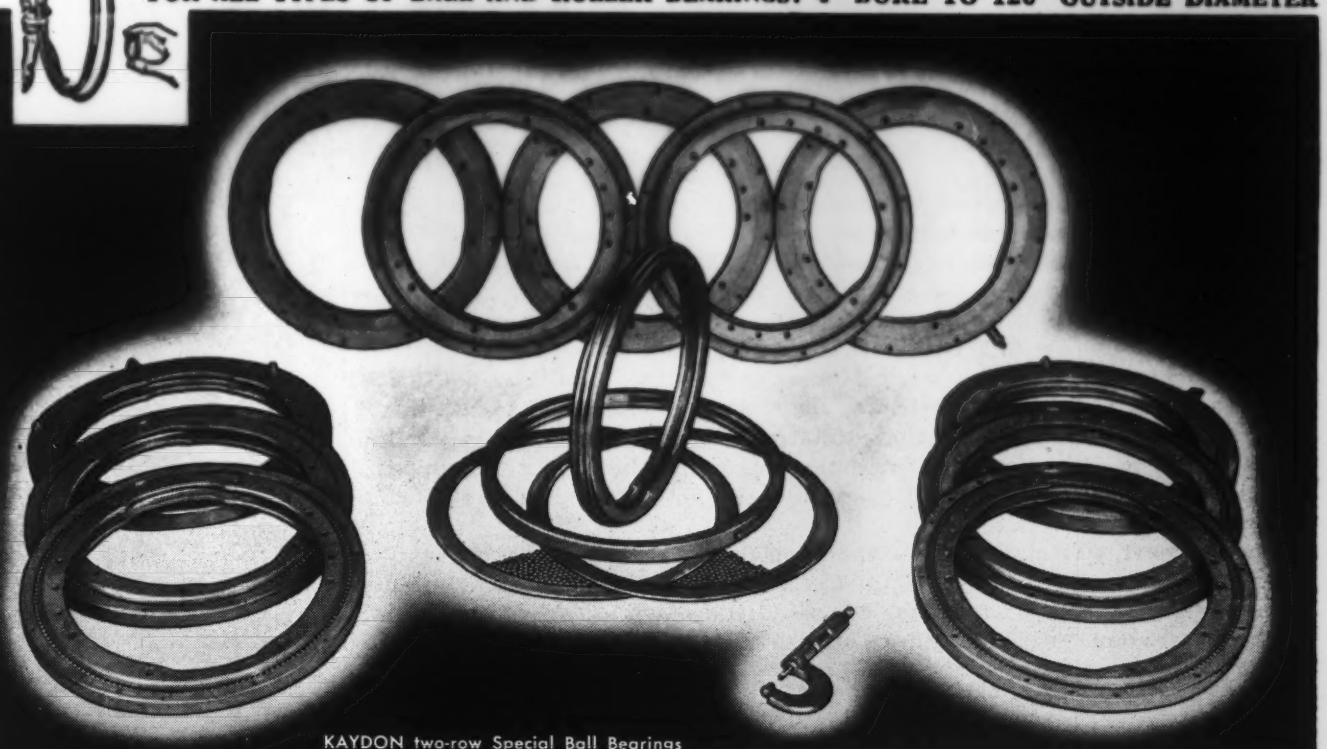
Plate Size (diam, in.)	1-Tube (1000 lb-in.)	2-Tube (1000 lb-in.)	3-Tube (1000 lb-in.)	4-Tube (1000 lb-in.)	Max Speed (rpm)
12	9	18	27	36	2000
16	25	50	75	100	1800
21¾	65	130	195	260	1500
25¾	116	232	348	464	1400
33¾	270	540	810	1080	1000

Design: 1, 2, 3 or 4 tubes and plates; compact, alloy-steel construction; large friction-face clearance when disengaged; disengaging springs prevent drag; "lock-in" device provided in case of air failure; heavy-duty ball bearings with mechanical shaft seal; air friction brakes of same general design, either spring-engaged and air released or vice versa, are available.

For more data circle MD 8, Page 199

Contact KAYDON of Muskegon

FOR ALL TYPES OF BALL AND ROLLER BEARINGS: 4" BORE TO 120" OUTSIDE DIAMETER



KAYDON two-row Special Ball Bearings
8.062" x 10.687" x .750"

Dependable Life-Savers ...KAYDON-bearinged Piasecki HELICOPTERS

CONTROL movements of Piasecki HUP Helicopters . . . life-savers of the air . . . are transmitted to the spinning rotor blade assemblies by means of a swash plate that moves on unique two-row **KAYDON** Special Ball Bearings.

Control of the helicopter is obtained by the movement of its rotor blades. Each blade can move in six different directions while they are rotating. Thus the mechanism responsible for control movements is complex, important, and it demands the utmost in bearing-precision.

KAYDON met the challenge of this intricate bearing-problem with these special two-row, thin section, 8.062" x 10.687" x .750" ball bearings. Similarly, **KAYDON** cooperates with designers of many types of precision equipment to achieve their objectives.

KAYDON Types of Standard and Special Bearings:
Spherical Roller • Taper Roller • Ball Radial • Ball Thrust
• Roller Radial • Roller Thrust • Bi-Angular Bearings

THE KAYDON ENGINEERING CORP.

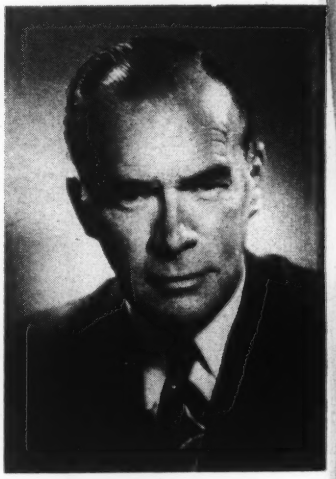
MUSKEGON • MICHIGAN

PRECISION BALL AND ROLLER BEARINGS

MEN OF MACHINES

A pioneer in the development of aircraft heat transfer and cabin pressure products, **S. K. Andersen** has been promoted to chief engineer of AiResearch Mfg. Co., Los Angeles. Having joined AiResearch in 1940 as chief of the laboratory, Mr. Andersen has been instrumental in the development of the company's heat transfer equipment. He was born in Denmark and came to the United States in 1924, two years after graduation from the University of Copenhagen with a degree in mechanical engineering. His first position was with Silica Gel Co. in Baltimore, for whom he became London manager. He later returned to the United States to join Minneapolis-Honeywell Regulator Co. in New York as installation engineer. Just prior to joining AiResearch he held the position of research engineer for Young Radiator Co., Racine, Wis.

Announcement was also made of the appointment of **Ivan Speer** as engineering manager at AiResearch Mfg. Co. of Arizona, Phoenix. Mr. Speer comes to his new position from the company's Los Angeles plant, where he has been assistant project engineer on gas turbine engines. He replaces **Arthur J. Phelan,** who has returned to Los Angeles as staff engineer reporting to **W. R. Ramsaur,** vice president in charge of engineering, on special assignments.



S. K. Andersen

N. J. Kassnel, who has been associated with the Verson Allsteel Press Co., Chicago, for ten years in the capacities of designer, chief draftsman and chief engineer, was recently appointed vice president in charge of engineering for the company. Replacing Mr. Kassnel as chief engineer is **Paul Kjelstrom,** who has served as design engineer and chief draftsman for the past eleven years. **Chris Zeilenga** has been appointed chief engineer for research and development. He has been associated with the company for 13 years as designer and assistant chief engineer.

N. J. Kassnel

O. A. Wheelon

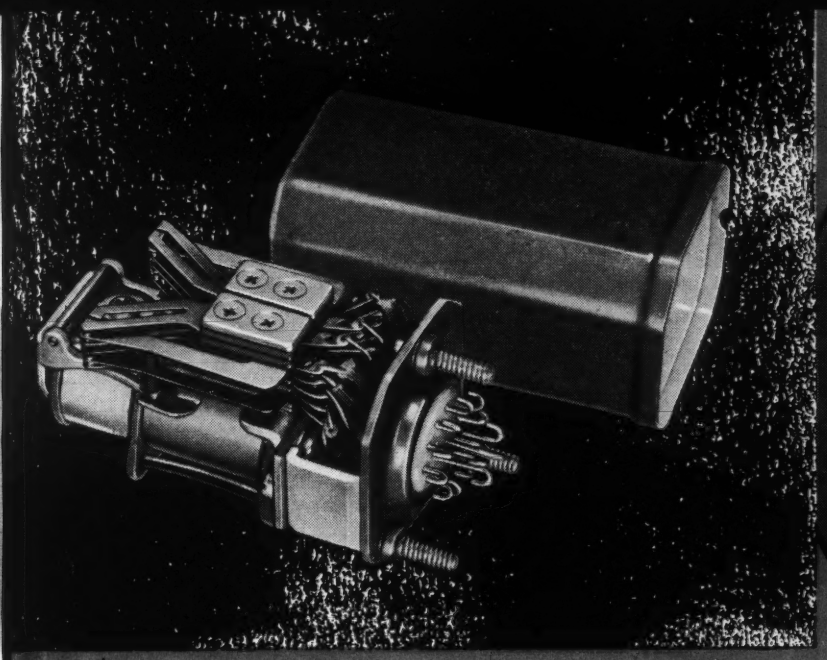
Production design engineer of Douglas Aircraft Co., Santa Monica, Calif., **O. A. Wheelon** has been awarded the Wright Brothers Medal by the Society of Automotive Engineers. He received the award for his paper, "Design and Manufacturing Techniques with Titanium," which was judged the best paper read before the SAE during 1951 on "aerodynamics or structural theory or research, or airplane design or construction."

Mr. Wheelon received a Bachelor of Science degree in mechanical engineering from the University of Iowa in 1931 and joined Douglas in 1934. He has devoted his attention to design and manufacturing research and analysis, one of his major projects being the direction of studies on design and manufacturing techniques for 75S aluminum alloy, which is used almost exclusively in the DC-6 series of transport aircraft. He also co-ordinated plant-wide processes for manufacturing integral wing fuel tanks and studies for producing effectively pressure-sealed airplane cabins. More recently he developed a compact, efficient high-pressure hydraulic press for use in air-

CLARE

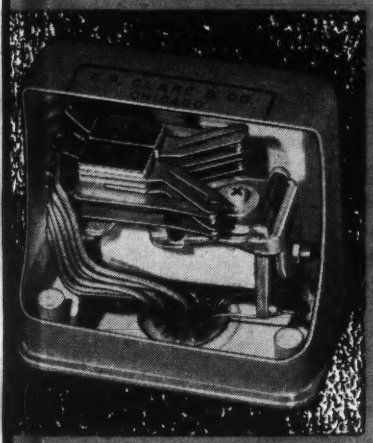
Hermetically Sealed

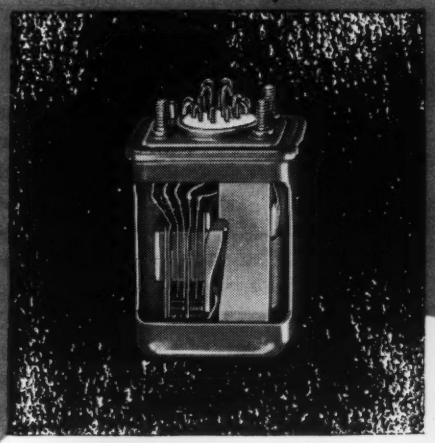
RELAYS



Clare Type "J" twin contact relay before sealing in enclosure.

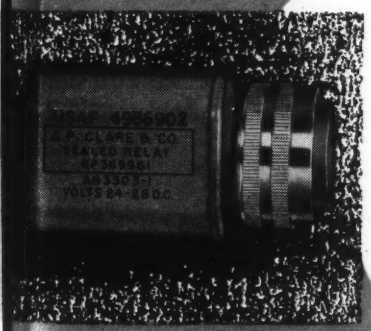
Cutaway view of Clare Type "K" hermetically sealed relay.





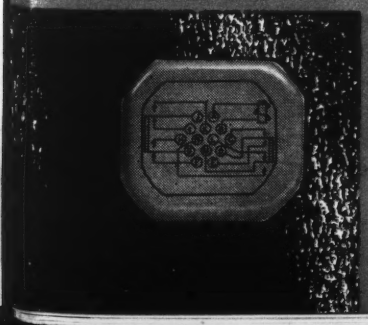
offer designers wide range of relays and enclosures

Another type of enclosure (cutaway) shows compactness of assembly.



"AN" approved Clare hermetically sealed relay with "AN" plug connector.

Connection diagrams are clearly and permanently imprinted on enclosures by silk screen process.



Long established as leaders in the design and manufacture of superior relays for all types of industrial use, C. P. Clare & Co. are pioneers in the development of a method of hermetic sealing which insures their long-life protection against unfavorable atmospheric and environmental conditions.

Hermetic sealing, as practiced by Clare, injects an ideal atmosphere of dry inert gas and seals it in to provide permanent immunity from the natural enemies of relays—moisture, pressure and density changes, salt, corrosive fumes, dust and fungi.

Fifty and more different series of Clare hermetically sealed relays are now available to relay users. Within each series innumerable variations of coil and contact specifications are possible.

For a full treatment of the subject of hermetic sealing—the Clare way—as well as a description of many types of Clare hermetically sealed relays, write for Clare Sales Engineering Bulletin No. 114.

Address C. P. Clare & Co., 4719 West Sunnyside Avenue, Chicago 30, Illinois. In Canada: Canadian Line Materials Ltd., Toronto 13.

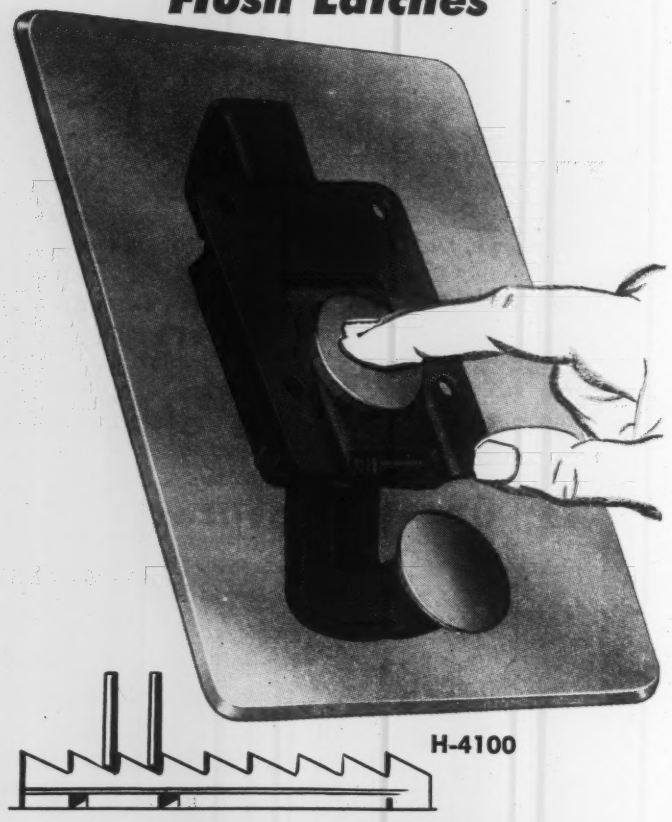
CLARE RELAYS

First in the Industrial Field

HARTWELL

sets a new pattern for the future with

Push Button Flush Latches



H-4100

***Improve* LATCHING Performance!**
***Go Modern* with HARTWELL**
Flush—Self-Closing—Easy to Operate—Simple to Install

Latch is operated by a natural rotation of the hand for push-and-lift positive action. As the forward button is depressed, the rear button raises, providing a sturdy grip for opening the door.

Your need for efficiency and economy today finds a powerful ally in the *Flush Latch* and *Hinge* talents of HARTWELL. Here is the latest *"push button"* method for solving your *flush* latching problems.

Write for engineering specifications and counsel.

HARTWELL
COMPANY

Manufacturer of Flush Latches and Hinges, Fittings and Cable Terminals.
9035 Venice Boulevard, Los Angeles 34, California

frame manufacturing and other metalworking industries.

♦

George V. Slottman has been elected a vice president of Air Reduction Co. Inc., New York. He has served as director of research and engineering since February 1949 and will continue in charge of that activity. Dr. Slottman was graduated from Massachusetts Institute of Technology in 1925 and received his Ph.D. from the University of Berlin two years later.

♦

The Kalart Co. Inc., Plainville, Conn., recently announced the appointment of **Edward K. Kaprelian** to the post of director of research and development. Mr. Kaprelian came to Kalart from the Signal Corps Engineering Laboratory, Fort Monmouth, N. J., where he has been chief of the photographic branch since 1947.

♦

Thomas J. Kelly has been appointed as design engineer in the newly created appliance control department of General Electric Co. in Morrison, Ill.

♦

Having served as assistant dean of engineering since February 1951, **Dr. Ralph G. Owens** has been named dean of engineering at Illinois Institute of Technology, Chicago. He succeeds **Dr. John T. Rettaliata,** whose appointment as president of the Institute was announced in the March issue of MACHINE DESIGN.

♦

Frank A. Brede recently joined Graton & Knight Co., Worcester, Mass., as chief engineer in charge of transmission and development in the company's research and development department.

♦

A consulting partnership has been formed under the name of Pi-Square Engineering Co., with headquarters at 400 Western Union Bldg., Boston 10, Mass., by **Dr. Henry M. Paynter,** assistant professor of hydraulic engineering at Massachusetts Institute of Technology, and **George A. Philbrick,** chairman and president of Philbrick Researchers Inc., Boston.

♦

J. T. Cataldo has been appointed assistant general manager of International Rectifier Corp., El Segundo, Calif.

♦

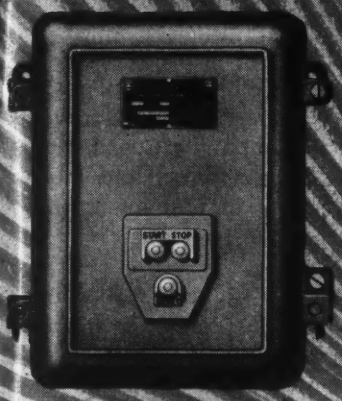
Kollsman Instrument Corp., Elmhurst, N. Y., a wholly-owned subsidiary of Standard Coil Products Co. Inc., has announced the appointment of **Herman Bergman** as director of statistical research and **Rear Admiral Clyde W. Smith,** USN, (Ret.) as assistant to the president.

♦

Announcement of the appointment of **E. G. Chartier** as manager of the engineering department has been made by The Sessions Clock Co., Forestville, Conn. Mr. Chartier came to Sessions from the Framingham Welding and Engineering Co., Framingham, Mass. Previously he was associated with General Electric Co. for twelve years, and during seven years of this

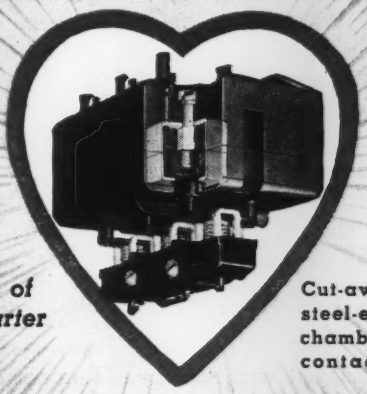
CLARK Type "CY" AC MOTOR STARTERS

in enclosures to meet every industrial requirement



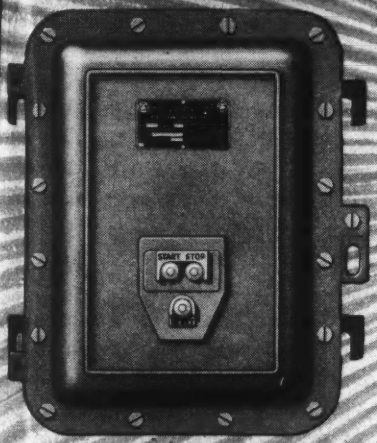
Type IX Cast Iron, explosion resisting enclosure for hazardous dust locations.

Type VII Cast Iron, explosion resisting enclosure for hazardous gas locations. A multi-speed starter.



The heart of the CY Starter

Cut-away view of steel-enclosed arc chamber with main contact assembly



Type VII Cast Iron, explosion resisting enclosure for hazardous gas locations.

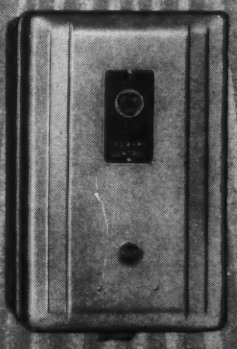
In CLARK Type "CY" Starters, sizes 2 and 3, the arc is extinguished by the effect of the blowout coils, *concentric with* the contacts. The steel arc chamber and the center stud form the magnetic field which rotates the arc—either lengthening or confining it. Because the arc moves continuously on the contact surfaces, burning and pitting is minimized, and contact life greatly increased.

These new starters are available in enclosures approved for use in such industrial atmospheres as hazardous gas, dust or excessive humidity.

Type V Dust Tight, Fabricated Steel enclosures, with gasket and Wing Nuts.

Type IX Cast Iron, explosion resisting enclosure for hazardous dust locations. A combination starter with circuit breaker.

Type I Fabricated Steel, general purpose enclosure.



Type IV Cast Iron, water tight enclosure.

CLARK Type "CY" starters with low maintenance assure more continuous production.

THE CLARK CONTROLLER CO.

ENGINEERED ELECTRICAL CONTROL • 1146 EAST 152ND STREET, CLEVELAND 10, OHIO

period he was connected with the Telechron department, where he was responsible for product design, gear engineering and affiliated engineering duties.

♦

O. S. Carliss and **George F. Quayle** have been appointed director of engineering and assistant director of engineering, respectively, of the Philadelphia division of Yale & Towne Mfg. Co. Mr. Carliss succeeds **Charles S. Schroeder,** who has been appointed director of the newly created company-wide research and development division, and Mr. Quayle replaces **Frank A. Vossenberg,** assistant director of the new division.

♦

Allis-Chalmers Mfg. Co., Milwaukee, recently appointed **Werner Orth** and **Donald J. Waalkes** as assistant engineers in the control section and the hydraulics section, respectively. **William C. Bullock** was named an engineer's assistant at the company's Pittsburgh works. These three men recently completed the company's graduate training course.

♦

Associated with the company for six years, **V. L. Miller** has been named chief engineer of Lee Wilson Engineering Co. Inc., Cleveland. He was previously in charge of research and development.

♦

S. T. Williams, who has been associated with Continental Motors Corp. in various engineering capacities for the past 17 years, has been appointed manager of engineering at the company's military division in Muskegon, Mich. Mr. Williams joined the company as a research test engineer in 1935, served as a liaison engineer with the company's Continental Aviation & Engineering Corp. subsidiary, and more recently was chief engineer of the amphibian tractor division.

♦

Norman C. Penfold, supervisor of automotive and engine fuels and lubricants research, has been named an associate director of Southwest Research Institute.

♦

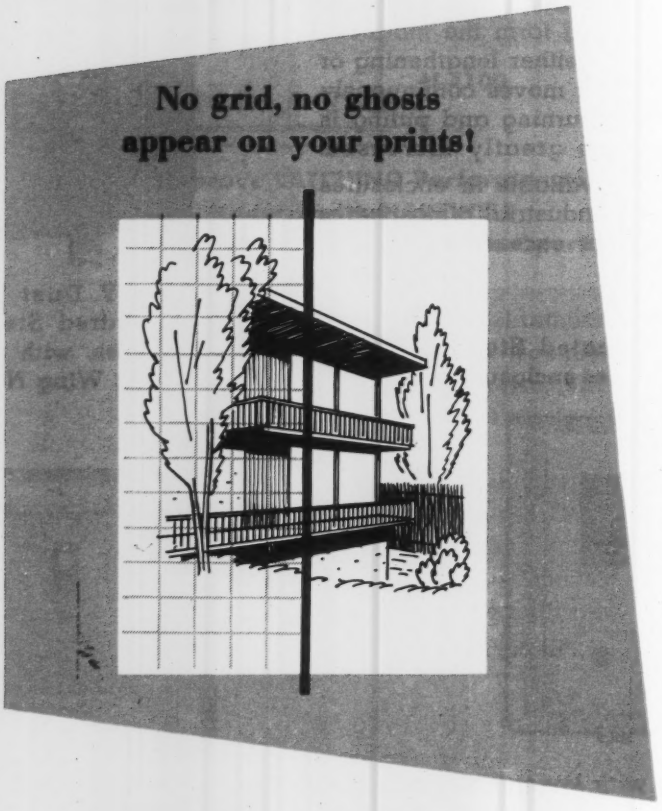
Several promotions in the engineering staff of The Timken-Detroit Axle Co., Detroit, were announced recently. **Walter S. Scheel** was promoted to chief engineer; **Lawrence G. Boughner,** to assistant chief engineer, development; **Kenneth M. Koch** to assistant chief engineer, application; and **William L. Pringle** to assistant chief engineer, military.

♦

Arthur R. Lytle has been appointed director of research of Union Carbide & Carbon Research Laboratories Inc., Niagara Falls, N. Y., **Walter Crafts** has become associate director of research, and **David Swan** is now assistant director of research.

♦

The Navy's Distinguished Civilian Service Award was recently presented to **Dr. Louis Ten Eyck Thompson** for his achievement in the field of Naval ordnance. Dr. Thompson was technical director of the Naval Ordnance Test Center, Inyokern, Calif., since its establishment in 1945, and is now a consultant to the



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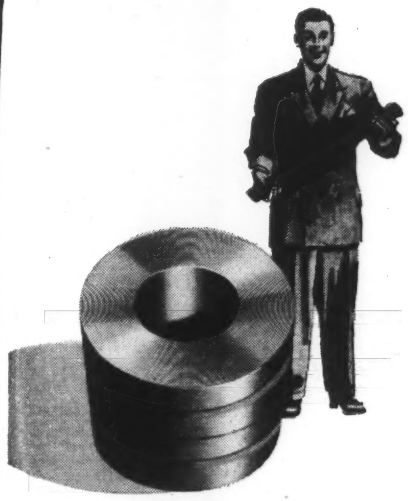
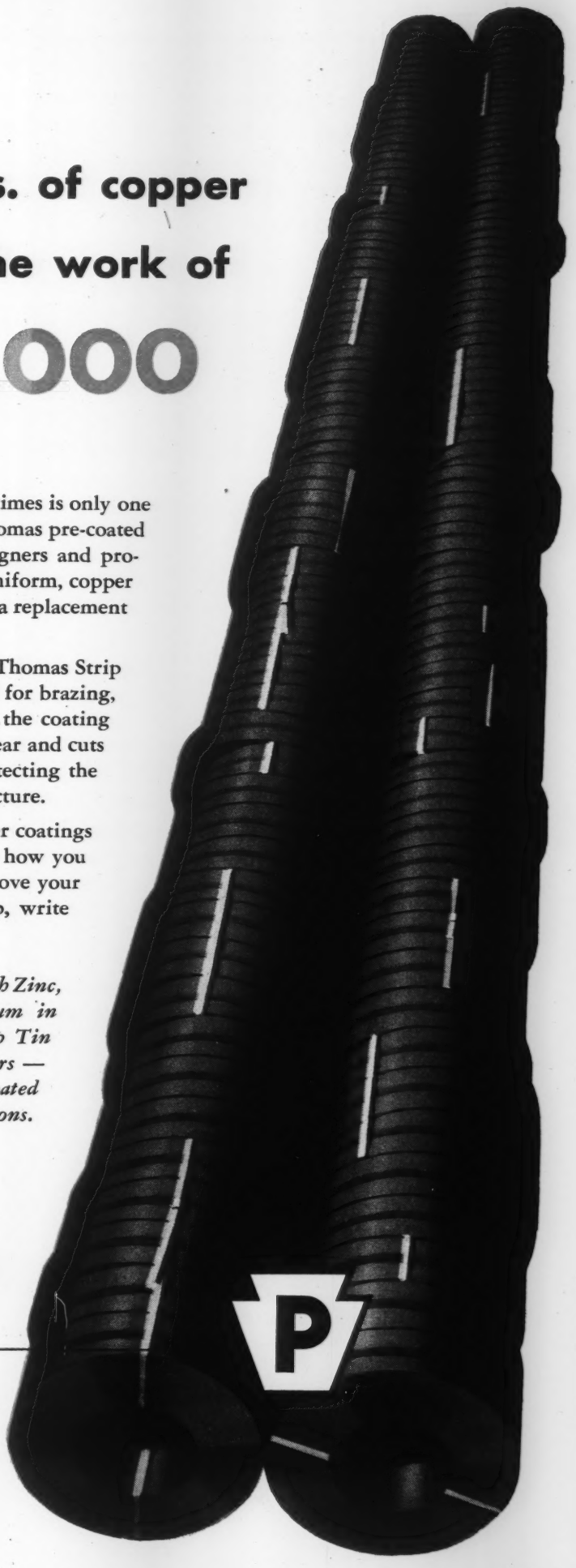


How 40 lbs. of copper does the work of 2,000



Stretching the usefulness of copper as much as 50 times is only one of the ways you can save critical materials with Thomas pre-coated cold-rolled strip steel. In many applications, designers and production engineers find that the tightly adherent, uniform, copper pre-coat on steel serves their purpose adequately as a replacement for the pure metal.

The uniform non-peeling coating of copper on Thomas Strip has many functional advantages and is widely used for brazing, tinning, and soldering operations. In fabrication, the coating acts as a die lubricant, increases die life, reduces wear and cuts retooling costs. It has the added advantage of protecting the base metal from rust during the course of manufacture.

Pre-coated Thomas Strip is also available in other coatings to save critical materials as listed below. To learn how you can help conserve scarce non-ferrous metals—improve your product and speed production with Thomas Strip, write today for information.

Cold-rolled strip steel electrolytically pre-coated with Zinc, Copper, Brass, Nickel, Lead-Alloy and Chromium in Natural, Planished and Buffed Finishes—Hot Dip Tin and Lead Alloy Coated — Lacquer Coated in Colors — Annealed Spring Steel—Alloy Strip Steel—Uncoated Strip Steel. Carefully produced to your specifications.

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Thomas Strip Division
Warren, Ohio

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or... how important is a SPRING?

• There's no doubt about it—without springs the mechanical world would be virtually paralyzed. For, like the human heart—in machine after machine, simple or complex, big or little the SPRING is the very source of motivation—the seat of power that propels . . . sustains . . . delays or stores up action.

For instance,—take any product which depends on a spring vital to its mechanism—very frequently a poorly designed spring will cause this product to fail in its performance, *a headache for any manufacturer*, AT THIS POINT—or even in the development stage while your production problem is still "HOT" is the right time to call in Automatic Spring Coiling Co., consulting engineers, trained in production methods and quality control, to bring ENGINEERING ABILITY to bear by providing the correct precision mechanical spring . . . at a minimum cost.

The successful manufacture and productive capacity in large quantities of automobile clocks, as well as, clutch thrust and driven plate springs, all manufactured to close tolerances . . . testifies to the reliable performance of the products of Automatic Spring Coiling Co., in this particular field. Automatic Spring Coiling Co. can supply compression, extension, torsion or double-torsion, helical springs of round or flat wire, flat spiral springs and flat or round wire shapes.

Why not let our experienced Consulting engineers survey your precision mechanical spring requirements without obligation—write today.

AUTOMATIC SPRING COILING CO.
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CHICAGO 30, ILLINOIS

president of Norden Laboratories, White Plains, N. Y. He retired from government service last October.

♦

Ekco Products Co., Chicago, has named **Robert W. Reinicke** as assistant vice president of manufacturing and engineering.

♦

Stephen J. Tompkins was recently appointed assistant chief engineer of the truck design section, engineering division of Chrysler Corp., Detroit. **Robert M. Rodger** succeeds Mr. Tompkins as chief engineer of the company's Jefferson and Kercheval plants.

♦

Bethlehem Steel Co. has appointed **Frank A. Baker Jr.** as chief engineer of its Sparrows Point, Md. plant, succeeding the late **John Bimestofer Jr.**

♦

Dr. Lewis Warrington Chubb, director emeritus of the Westinghouse Research Laboratories and a leader in the field of science, died April 2. A veteran of more than 42 years of service with the Westinghouse Electric Corp., Dr. Chubb was director of research from 1930 until September 1948, when he retired from active direction of the laboratories and was named director emeritus.

♦

Weirton Steel Co., Weirton, W. Va. has appointed **W. Harry Wright** to the position of chief engineer. He succeeds **Clarence J. Klein,** who was named vice president of engineering.

♦

John A. McMillan was recently appointed plant engineer for the Shelbyville, Ind., manufacturing plant of Pittsburgh Plate Glass Co., Pittsburgh. Mr. McMillan has served during the past five years as plant engineer for Duplate Canada Ltd., and previously was associated with Research Enterprises Ltd. as chief mechanical engineer and with the National Research Council as a research engineer.

♦

Champion Rivet Co., Cleveland, has elected **C. P. Diemer** to the post of vice president in charge of engineering.

♦

In an expansion of its technical research program, Ryan Aeronautical Co., San Diego, Calif., has appointed **Alexander Pechman,** ceramic engineer, to the staff of its development laboratories. Mr. Pechman will be concerned with testing, improving and developing ceramic coatings for jet, rocket and internal combustion engines.

♦

Stephen M. Martin was recently appointed mechanical engineer by Storts Welding Co., Meriden, Conn.

♦

Bath Iron Works Corp., Bath, Me., and its subsidiary, the Pennsylvania Crusher Co., Philadelphia, have announced that **Edwin H. Keiper** has been made chief engineer of the latter company. Mr. Keiper joined the company as a draftsman in 1919. He was appointed chief design engineer in 1939 and held that position until 1949, when he became chief service engineer.

"Standardized on NORGREN for years... Extremely Satisfactory"

NATIONAL ELECTRIC WELDING MACHINES CO.

PLANT REPORT

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To find standard lubricating, air pressure regulating, and air line filtering equipment which would be readily available in sizes and types for easy make up into various assemblies for a wide range of specially designed production-line resistance welders.

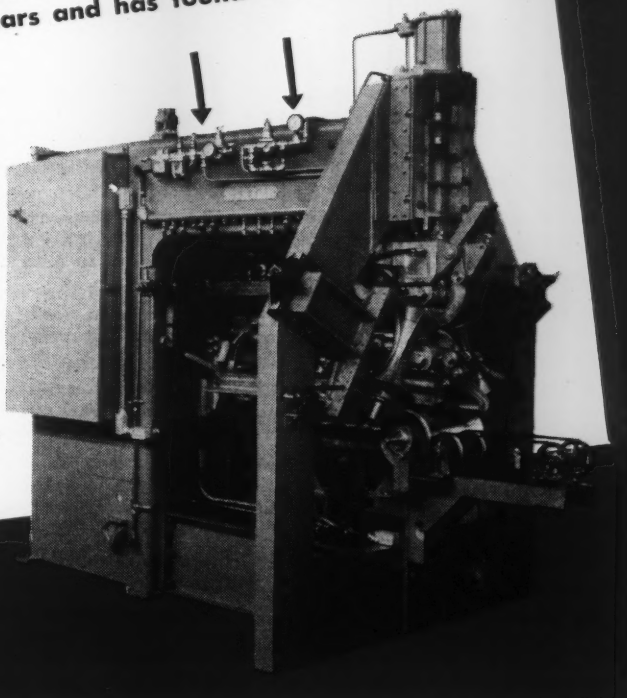
SOLUTION:

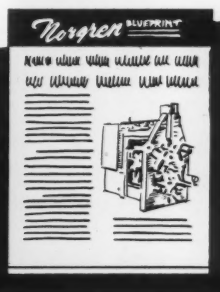
Use of Norgren Lubricators, Regulators, and Filters.

RESULTS:

"National Electric Welding Machines Company has standardized on Norgren air accessories for years and has found them to be extremely satisfactory.

This special 200 KVA Seam Welder automatically roll-forms, sizes, feeds and mash-seam-welds metal containers from 15" to 25" dia. and 10" to 30" long. This is a typical National Electric Welding Machine Company product, using Norgren lubricators, air line filters and air pressure regulators. Primary air pressure ranges from 80 to 100 psi; secondary from 60 to 80 psi.





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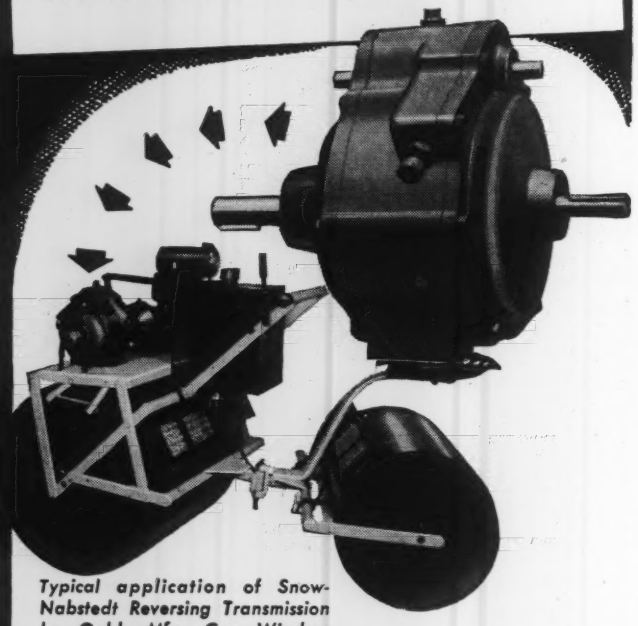

Typical application of Snow-Nabstedt Reversing Transmission by Gabb Mfg. Co., Windsor Locks, Conn. on its "Motoroller".

- SO UNIQUE — One unit combines forward, neutral, reverse and reduction . . . no separate clutch required! Has coaxial input-output shafts.
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- SAVES MONEY — Eliminates separate gear box, clutch, countershaft and mounting brackets in many applications. *SAVES assembly time, servicing problems, and improves product appearance.*
- SAVES SPACE — The most compact transmission available . . . only 9-1/16" x 8" x 9-1/2".
- QUALITY-ENGINEERED—Designed by makers of Joe's Famous Gears, world-renown for 46 years. Have our capable engineers produce transmissions to serve your defense equipment needs!

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THE ENGINEER'S Library

Advanced Engineering Mathematics

By C. R. Wylie, Jr., chairman, department of mathematics and astronomy, University of Utah; published by the McGraw-Hill Book Co., New York; 640 pages, 6 by 9 inches, clothbound; available through MACHINE DESIGN, *$7.50 postpaid.*

Intended for advanced engineering students and practicing engineers, this self-explanatory treatment of advanced mathematics may be conveniently used as a reference text. A good background in calculus is assumed. Material from the borderline between calculus, advanced calculus and the theory of equations is covered in an extensive appendix.

Differential equations are treated first, followed by a chapter on electrical and mechanical vibrations. Succeeding topics covered are: Fourier series, Laplace transformation, partial differential equations, Bessel functions, analytic functions of a complex variable, integration and infinite series in the complex plane, theory of residues, conformal mapping, analytic functions and fluid mechanics, and vector and numerical analysis. Several hundred problems varying in degree of difficulty are included to aid mastery of the material.

□ □ □

Extrusion of Plastics, Rubber and Metals

By Herbert R. Simonds, Archie J. Wieth, and William Schack; published by Reinhold Publishing Corp., New York; 454 Pages, 6 by 9 inches, clothbound; available from MACHINE DESIGN, *$10.00 postpaid.*

Written in collaboration with a special industrial advisory committee, this book is a treatise on commercial extrusion processes. Equipment, method and materials are the essential topics covered with emphasis placed on new developments. The main portion of the text, devoted to the extrusion of plastics, is believed to be the first comprehensive published treatment of this subject. An extended appendix contains a glossary of terms, relevant tables, and lists of manufacturers of extruded products and extrusion machinery.

Part 1 of the text, on extrusion of plastics, makes up about two thirds of the book and has chapters on the plastics extrusion industry, economics, custom extrusion, plastic materials for extrusion, process of

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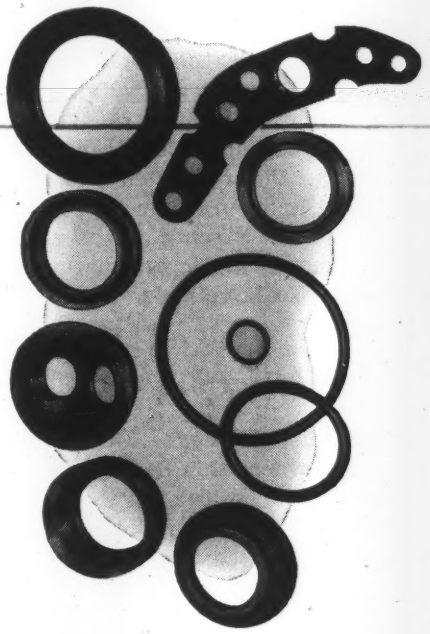

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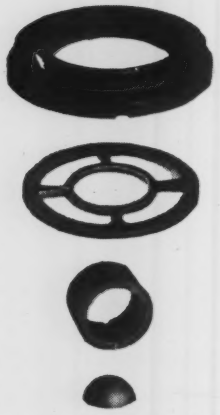

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plastics extrusion, equipment for plastics extrusion, theoretical aspects, conditioning of compounds, design and use of dies, instrumentation, monofilaments, shapes and tubes, sheeting and films, plastic coatings on wire and other products, and applications. In Part 2, extrusion of rubber, metal and miscellaneous materials is dealt with.

□ □ □

Hydraulic Transients

By George R. Rich, consulting engineer; published by McGraw-Hill Book Co., New York; 260 pages, 6 by 9 inches; clothbound; available from MACHINE DESIGN, *$7.00 postpaid.*

Written for design engineers in the hydraulic and hydroelectric fields, this reference text emphasizes the application of arithmetic integration and trial-and-error arithmetic to the solution of problems in hydraulic transients. In a few cases, operational calculus is used to develop fundamental theory; however, knowledge of this mathematical approach is not essential to an understanding of the text. One of the series of Engineering Societies Monographs, the book is sponsored by the ASCE, ASME, AIME and AIEE.

The first eight chapters of the book cover separate hydraulic transient problems: water hammer, turbine speed regulation, stability of governing, water-hammer pressures in pump discharge lines, the differential surge tank, the restricted-orifice surge tank, navigation locks, and surges in power canals. In the concluding chapter, elements of the graphical method of water hammer analysis are discussed and co-ordinated with analytical methods.

Manufacturers' Publications

Aluminum Powders and Pastes: Designed as a manual on aluminum powders this 84 page booklet is appropriately subtitled: "The Tale of the Powdered Pig." Introductory chapters trace the development of aluminum powders and discuss modern production methods. Applications are treated next and comprise the main portion of the content. Emphasis is placed on the use of powders and pastes in paints and coatings. Other applications discussed are pyrotechnics, heat reactions, chemical processing, powder metallurgy, surgery and silicosis, and miscellaneous special uses. Concluding chapters cover physical and chemical properties, testing and evaluation methods, and recommended handling and storing procedures. Copies of this 6 by 9 inch booklet can be obtained by request on company letterhead from Reynolds Metals Co., 2500 S. Third St., Louisville 1, Ky.

Flexible Shaft Handbook: This third edition incorporates changes and developments in flexible shafting made since 1944. The text, introduced by a brief section on nomenclature and general features of flexible shafts, has five parts. Applications, construc-

tion, characteristics, selection, and installation of shafts for power drives and for remote control are covered in the first two parts. The succeeding parts discuss flexible casings, shaft connection methods, and adapters. An appendix of general engineering tables and data concludes this 256-page reference manual. Clothbound and 5½ by 8½ inches in size, copies of the handbook are available by request on company letterhead from the S. S. White Industrial Division, 10 E. 40th St., New York 16, N. Y.

Government Publications

NACA Technical Series: Each of these reports is 8 by 10½ inches in size, paper-bound and side-stapled, and contains complete drawings and illustrations. The following Technical Notes are available:

2435. Direct-reading design charts for 75S-T6 aluminum-alloy flat compression panels having longitudinal extruded Z-section stiffeners—60 pages: charts, which cover a wide range of proportions, facilitate determination of stress and all panel dimensions required to carry a given intensity of loading with a given skin thickness and effective length of panel

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2564. Properties of honeycomb cores as affected by fiber type, fiber orientation, resin type, and amount—36 pages: results of an investigation on honeycomb core structures made from nonwoven cotton, nonwoven rayon, and paper.

Copies of these reports may be obtained from National Advisory Committee for Aeronautics, 1924 F St., Washington 25, D. C.

Association Publication

Proceedings of the National Conference on Industrial Hydraulics; Vol. V: Paper-bound and containing 202 pages, this volume presents technical papers and panel discussions from the 7th annual meeting of the Conference, November 7-8, 1951. Fundamental and applied phases of industrial hydraulics are covered; topics include: general information, instrumentation, automotive applications, civil engineering, pumps, material handling, packings and filters, viscosity measurement and hoses, accumulators and presses, and oil wells and fluid transportation. Copies of the 6 by 9 inch volume are available for $4.50 each from John G. Duba, Conference Secretary, National Conference on Industrial Hydraulics, Technology Center, Chicago 16, Ill.

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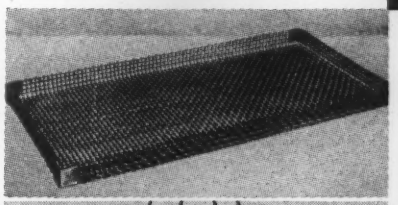
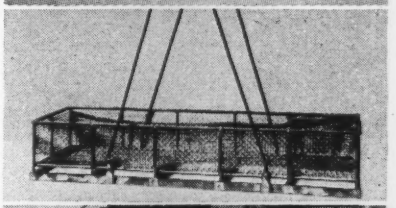
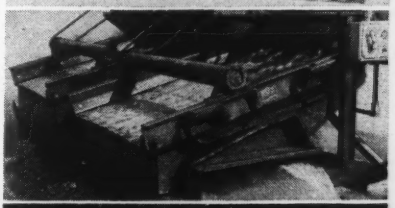


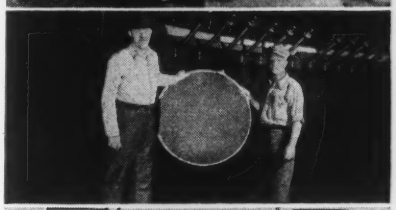
heat treating?



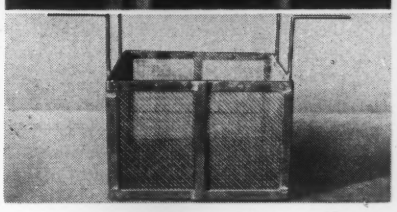
pickling?



screening?



filtering?



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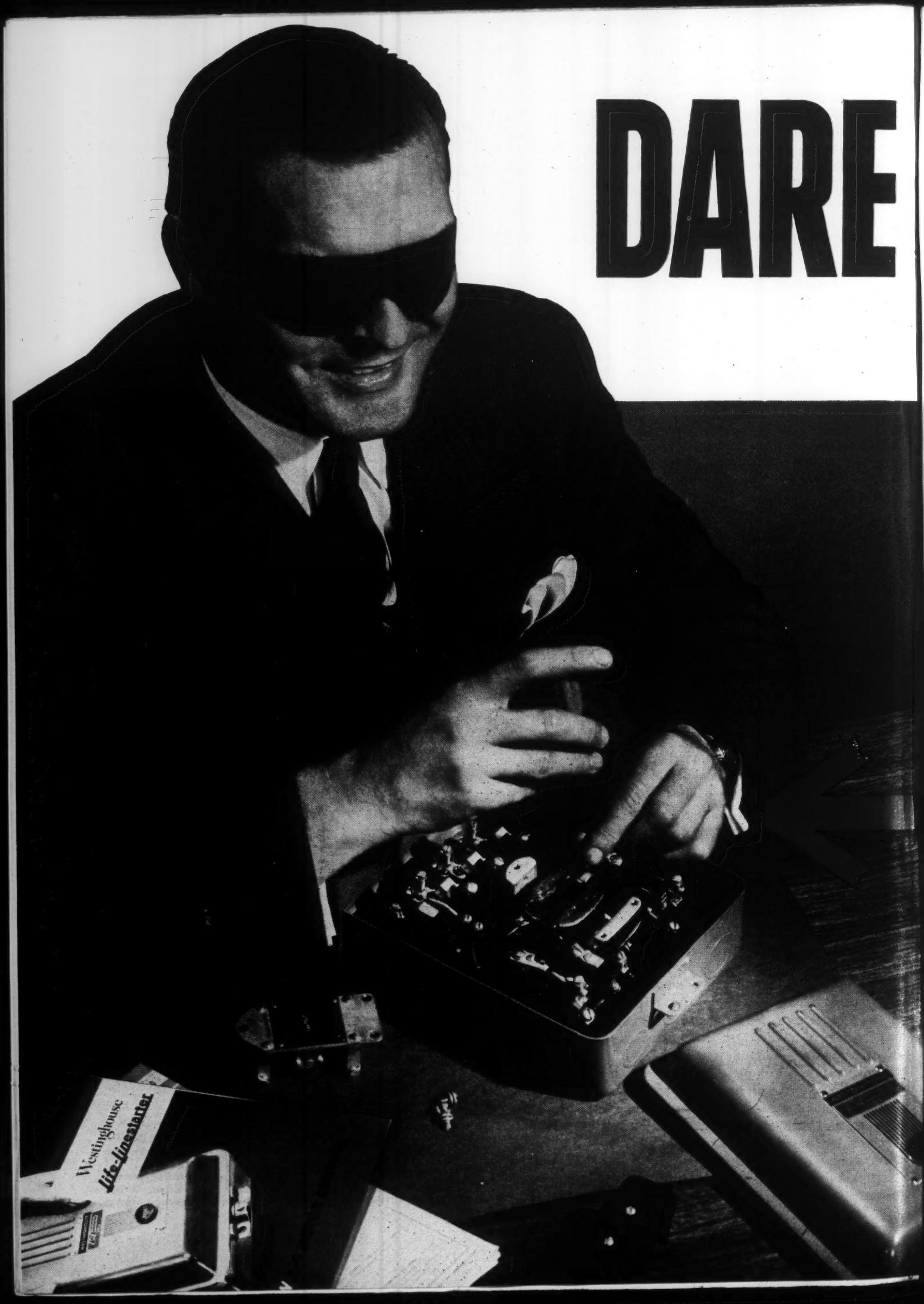
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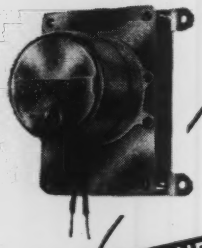

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SYNCHRON synchronous motors meet your requirements for compact power. Pulls up to 8 oz. direct load continuously at 1 R.P.M. Gear trains can be furnished to convert to any speed. Unusual actions can be incorporated in movement. Our engineers will be glad to work with you in developing motors for special applications.

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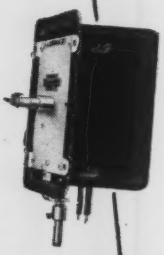

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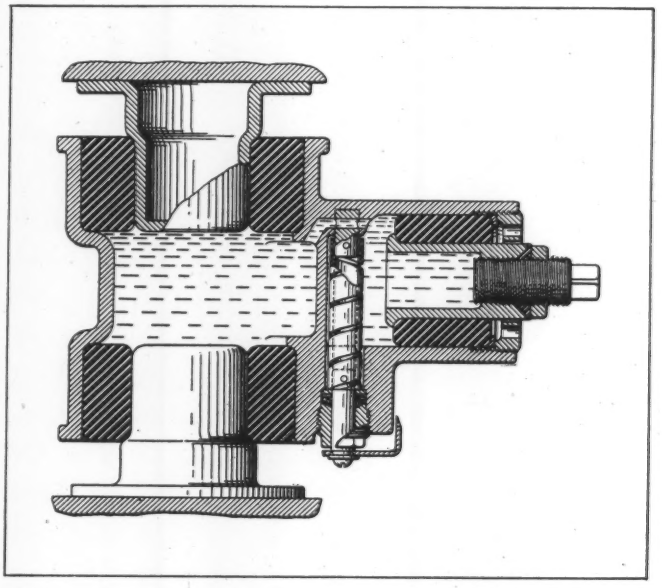
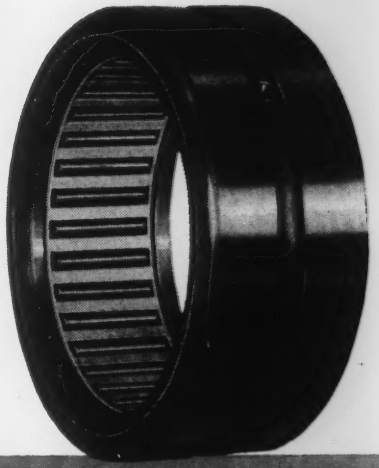
BIMETALLIC SPIRAL COUPLING in a fluid-modified vibration absorption mounting automatically adjusts a control orifice according to fluid temperature. This compensates for thermal viscosity changes, thus assuring constant damping effect. A calibrated adjustment is provided to set the orifice for most effec-



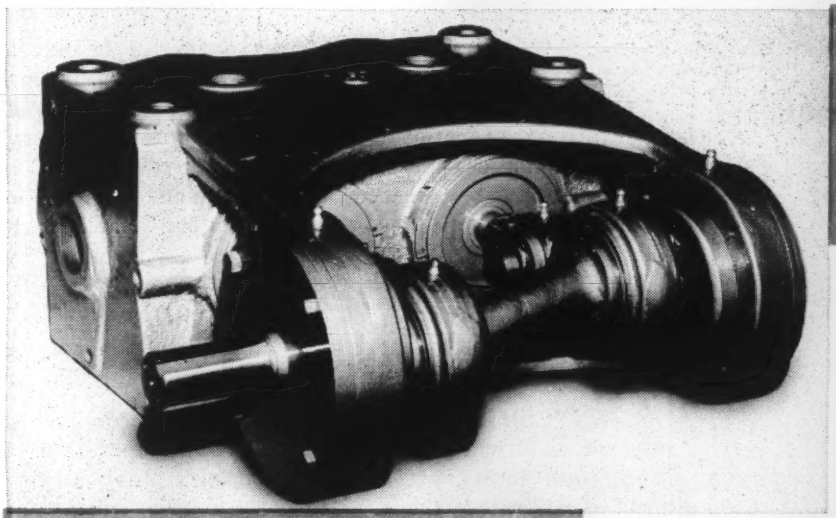
tive damping axially while the mounting is under load. Thus, under conditions of resonance, the adjustable fluid-damped mounting is capable of preventing undue amplitudes of vibration. Without changing the inherent radial absorption characteristic of the elastic mounting bushings, axial load capacity of the mount may be varied through adjustment of a threaded compression plug in the fluid chamber. When single-direction damping action is desired, a check valve is built into the housing to bypass the orifice one way. Patent 2,582,363 assigned to the General Tire and Rubber Co. by Leon F. Thiry.

FLOATING CYLINDRICAL RACK co-ordinates the positioning of three hemispherical rollers in a variable-speed friction gear. Located in the center of a stationary carrier between input and output disks, the rack meshes with segment gears of individual roller carriers. By manual control of a dial coupled to one carrier, the three roller assemblies are tilted simultaneously to alter the speed ratio which is variable infinitely between top speed and zero. To obtain zero output speed without swinging the rollers to an undesirable position of polar contact, a hollow-shaft bypass gear train between input and output disk is

How Rialto Hydraulic Pumps save space-gain load capacity-increase bearing life on connecting rods



● **This Model 201 Rialto Hydraulic Pump is a two-stage fluid pump, featuring a low pressure phase and a high-pressure phase, operating independently. It is used for closing blow-out preventers in oil well drilling. Made by The Rialto Corp., Rialto, California.**



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Rialto engineers selected Orange Cage Type Needle Bearings for the main crankshafts because the exclusive cage design prevents roller skewing. All rollers are held in permanent alignment by a land-riding cage made of anti-friction, non-ferrous metal.

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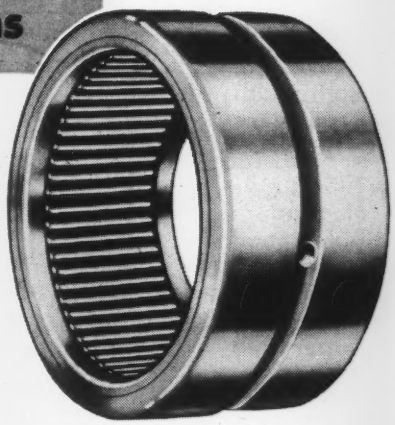
ORANGE ROLLER BUSHINGS used on Wrist Pins



Smooth, friction-free oscillating motion of the two wrist pins is obtained by the use of Orange Roller Bushings. Closer internal running clearances minimize possibility of misalignment of rollers, eliminating bearing trouble at these critical spots.

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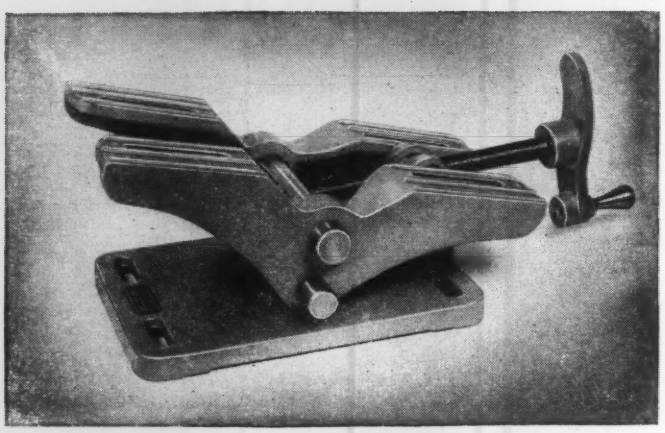

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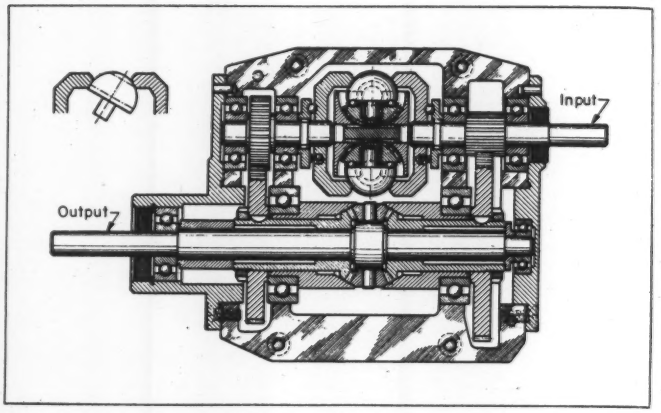
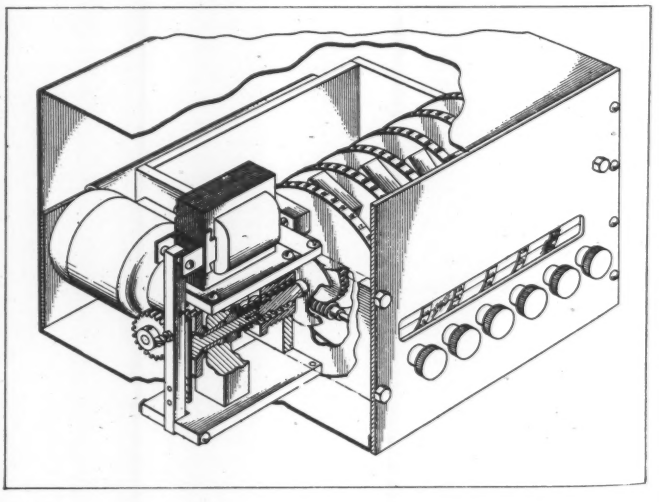


built into the reducer. Output shaft of the unit rotates inside the hollow bypass shaft and is driven differentially by a pair of opposed bevel ring gears through stud mounted bevel pinions on the output shaft. At predetermined maximum angular setting of the roller carriers, the hollow-shaft ring gears rotate in opposite direction at equal speed, resulting in zero velocity of the output shaft. Patent 2,545,152 assigned to Ebauches S. A., Grenchen, Switzerland, by Hans Haidegger.

CENTESIMAL-SECOND TIMING is accomplished in an electrical sequence timer by cam operation of precision limit switches mounted on rotary adjustable calibrated disks. Knob-controlled worm and gear adjustments position the switch mounting disks relative to a series of dog type cams for presetting a given cycle. By solenoid operation of a combination tapered friction brake and clutch, the camshaft assembly is unlocked and coupled to a constant-speed motor. Low inertia of the lightweight cam assembly permits almost instantaneous acceleration of the moving parts. The timer was devised primarily for controlling closely spaced sequential events inherent in the operation of cloud chambers to provide photographic records of ionization. Patent 2,574,841 assigned to the U. S. Atomic Energy Commission by Wilson M. Powell and Albert W. Hughes.



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Diamond Roller Chains provide the dependable, non-slipping, sturdy drive at low cost. In fact, it would be difficult to imagine a simpler manner of accomplishing the driving of such a machine. Gears would be heavy, impractical and costly, besides requiring a multiplicity of shafts. Belts could not provide the positive, non-slip power transfer nor withstand exposure to the elements.

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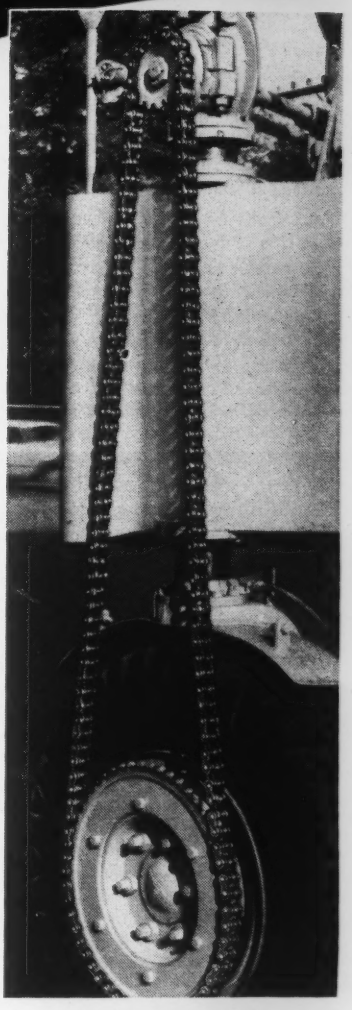
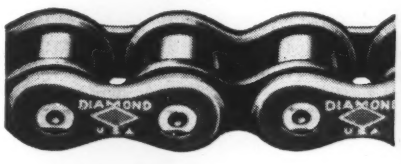
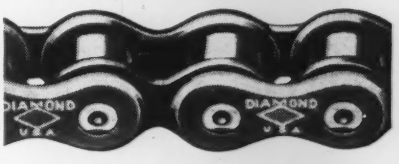


On this Gerlinger Carrier, Diamond Roller Chains drive the two rear wheels from shafts above.



DIAMOND ROLLER CHAINS



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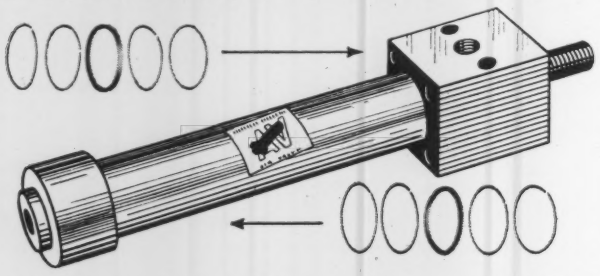
LOWERS MANUFACTURING COSTS
PROVIDES BETTER CYLINDER EFFICIENCY



Heavy duty Airmatic cylinders, made by Airmatic Valves, Inc., Cleveland, and widely used in the aircraft and other industries, now use PALMETTO G-T Rings in place of conventional type packings.

By employing G-T Rings—which require only a rod and piston groove—Airmatic has been able to simplify cylinder design; eliminate complicated stuffing boxes, back-up plates and hold-in bolts. As a result, manufacturing costs have been drastically reduced.

And, because G-T Rings—unlike conventional Rings—cannot roll in the groove under high pressure, spiralling and extrusion of packing is no problem . . . smooth, efficient performance is assured with minimum servicing of packing. Heavy duty Airmatics, with 1" bore cylinders, operate at pressures up to 1500 psi on oil or water—exert a force on the ram equal to 78% of the input. More than 5,000,000 trouble-free 3" strokes have been recorded on original Airmatic cylinders with PALMETTO G-T Rings.

HOW PALMETTO G-T RINGS WORK . . .

Fig. 1 shows Palmetto G-T Rings with no pressure applied. CLEARANCES between the FLANGES of the RESILIENT SECTION and the laminated plastic NON-EXTRUSION RINGS, as well as between rings and CYLINDER WALL prevent low pressure friction.

Fig. 2 indicates how the RESILIENT SECTION flows under pressure, causing the FLANGE to swell under the rings on the low pressure side, bringing them to bear on the CYLINDER WALL. CLEARANCE spaces are closed, preventing any extrusion of the packing material. The piston, forced to a central position, will move forward without binding or jamming and with no damage to packing or CYLINDER WALL. Elimination of extrusion of the packing material is the outstanding feature that makes Palmetto G-T Ring Packing the ultimate in seals.

If a better packing will better the product you make, count on Greene, Tweed to lend assistance. Write for literature that describes all PALMETTO Packings.

packing more performance into every application

PALMETTO Packings

GREENE, TWEED & CO. NORTH WALES, PA.

PROFESSIONAL
Viewpoints

". . . I propose . . . a society of inventors"

To The Editor:

The purpose of the patent office is to encourage and to bring into the public domain new ideas, designs or patents that may eventually benefit the public. A very high percentage, if not a majority, of the patents obtained prove unmarketable—a waste of intellect, time and money.

This fact may be lamentable in result, but is considerably more so in effect. The number of valuable and useful ideas that never reach the patent stage is uncountable, but may readily be considered great, due more to a feeling of uncertainty than to the actual obstacles involved.

I believe that at any time in the progress of this country, and more particularly so at the present, it is to our interest to encourage to the fullest extent the development of original ideas by our citizens; ideas that may benefit industry, the public, and the individual involved.

To this end I propose to organize, or at least to initiate the organization of a society of inventors. This society would seek to accomplish its avowed purpose through a calculated process of evaluation, assistance, advice and protection, the latter for both the individual and the manufacturer, since it is contemplated that much of this evaluation will be based on intensive liaison with industry.

It is fairly certain that such a society could not operate satisfactorily on a small scale, requiring, as it would, a competent legal, technical and liaison staff. An original sponsor, or sponsors, would probably be necessary. It would naturally be a non-profit making organization, and could very likely be made self-sustaining by the sale of its own publication, the collection of dues, and a set low percentage return from any satisfactorily prosecuted invention.

—CHARLES A. VOGEL
Valley Stream, L. I., N. Y.

Mr. Vogel has prepared a comprehensive outline of his proposed organization, which he is prepared to discuss with others interested in the protecting of inventions. Comments from readers of MACHINE DESIGN would be most welcome.—ED.

"From an engineering standpoint the turbojet is still experimental. We are a long way from having exhausted its possibilities. And we are going to have to use the best of our brains and experience to do just that and to keep our turbojets a safe margin ahead of any possible enemy's."—E. W. RAWLINGS, *lieutenant general, U. S. Air Force*

Use WELDED STEEL for Greater Strength with Less Weight!

The twenty-ton weldment above is one of many heavy fixture parts produced by Mahon for the defense production program. It, and the Steel-Weld Fabricated parts and assemblies illustrated at the left, are typical of thousands of units Steel-Weld fabricated and machined by the Mahon Company for manufacturers throughout the country. Do you have parts or assemblies in your product that could be redesigned for more economical production in welded steel? . . . do you have products in the development stage in which Steel-Weld fabricated parts could reduce weight without sacrificing strength? . . . are you faced with limited production on an item involving heavy pieces in which pattern costs are a consideration? If so, it will pay you to familiarize yourself with Mahon facilities and technical services . . . you will find in the Mahon organization a unique source with complete, modern fabricating, machining and handling equipment to cope with any type of work regardless of size or weight . . . a source where skillful designing and advanced fabricating technique are supplemented by craftsmanship which assures you a smoother, finer appearing job, embodying every advantage of Steel-Weld Fabrication.

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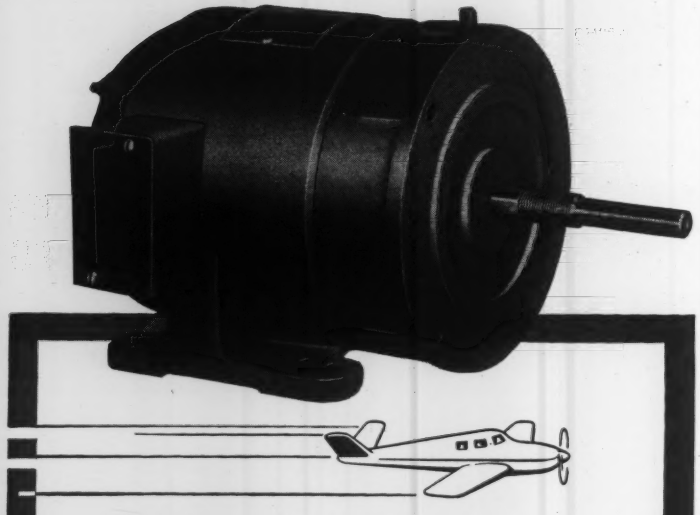

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ALL Peerless Motors ARE "PEERLESS REGISTERED"

Fabrication

(*Concluded from Page* 167)

long strips, contoured to the proper airfoil, and then simply cut to the desired length during assembly. G. E. engineers found this process adaptable to turbojet manufacture. Base for the blade, which is an integral part of the forged blade, was the big problem. This problem was solved by making a separate base having an opening so that the blade could be inserted and welded into it. The base is so shaped that it fills the same area as the present blade ring, thereby eliminating the usual blade ring and an expensive manufacturing and assembly process.

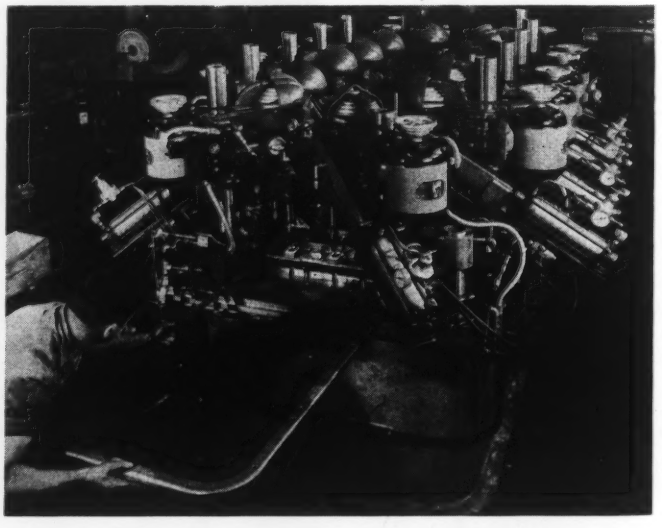
Design of the base is such that it provides greater resistance against vibration that may occur due to occasionally uneven air flows through the compressor. The new blade is much more strongly fastened to the casting, which will minimize the damage caused by a foreign object entering the compressor. Both of these items contribute to longer and safer engine life.

Drills 24 Holes Simultaneously

A SPECIAL production machine consisting of 12 standard drill presses drills 24 holes simultaneously into steel frames for military caskets. The Delta drill presses are mounted on the table of a machine base and positioned around a work-holding fixture.

A two-spindle drill head is mounted on each of the 14-inch drill presses. To provide necessary clearance for feeding and discharge, the drill presses on each end of the table are mounted on offset brackets. An operator feeds the steel frames into one end of the production setup; after the drilling operation is completed, the workpiece is withdrawn from the opposite end.

Drill press feeds are automatically actuated and controlled. Coolant is piped directly to the drilling points by a centralized lubrication system.



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MIL-B-5687 A Type 1 Composition A	Approved by Departments of Army, Navy and Air Force for procurement of bearings.
U. S. Army 57-230-2 Type 1 Composition A	Bearings used by all agencies of U. S. Army including Ordnance and Signal Corps.
SAE Gen. Instr. P221-1951 Handbook Type 1 Class A	Bearings used by automotive and related industries.
AMS-4805A	Bearings used by aircraft manufacturers and sub-contractors.

Use "Compo" H

ASTM B202-45T Type 2 Class B	Bearings purchased by industry.
ASTM B222-47T	Structural parts used by industry.
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U. S. Army 57-230-2 Type 2 Composition B	Bearings used by all agencies of U. S. Army including Ordnance and Signal Corps.
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Just about every major powder metallurgy specification—whether it's issued by government agencies or by official societies—is met either by "COMPO" H (oil-retaining porous bronze) or "POWDIRON" 61-P (sintered iron). Special alloys in "COMPO" and "POWDIRON" are also available to meet specific or unusual requirements.

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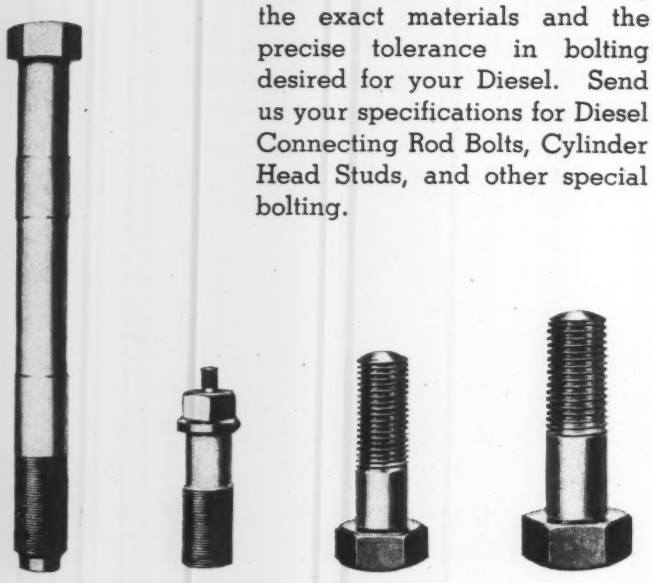

A SUBSIDIARY OF Barium STEEL CORPORATION Steel right to the bottom

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Stress Relief

FROM J. P. Henderson's file of standout characters he's known in his days of engineering administration, we've picked last month's opposite number.

That Silent Engineer

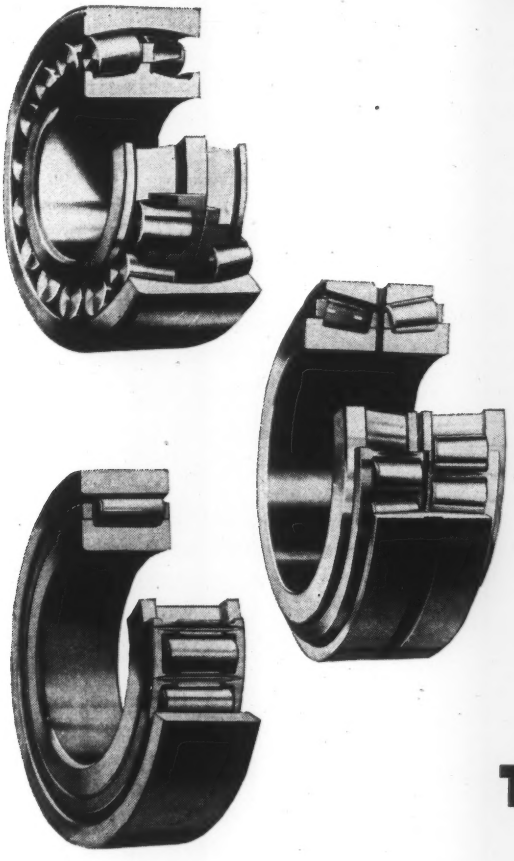
Do you know this type? He's that quiet fellow who works away steadily and with apparent enthusiasm. Offhand you would imagine any employer would be glad to have him and more like him as assets in any engineering department. Maybe. Try giving him some responsibility where his duties should require that he report to the boss on his work, his projects, or his problems. The chances are that his silence extends to the boss also! Compared to the talkative detail man, he may seem to be a blessing, but the trouble is that the boss can readily lose patience in trying to pry information from him.

More seriously, the boss can be left in a position of having important jobs fail—or succeed—long before he ever hears of them. Then when questioned by *his* superiors, he is caught in the apparent condition of not knowing what is going on in his department.

The ideal employee cultivates that newspaper headline technique, as previously recommended, and keeps his boss informed briefly of important progress. But suppose the employee is uncertain as to what is expected of him in this respect. Ask! When a job is given him it is not difficult to inquire, "Do you want a brief verbal progress report on this regularly? Shall I wait until the job is done and let you know?"

By a few such inquiries, any new employee can get the gist of what is expected of him. But the silent engineer wouldn't report to the boss if his desk were stolen right out from under him. The silent type usually suffers from another result

...for an impartial decision



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You can be sure of an impartial decision from Torrington which makes *every* type of anti-friction bearing. In addition, Torrington engineers have had broad experience in applying anti-friction bearings to virtually every type of equipment —from household appliances to steel mill machinery.

This experience and an understanding of customers' problems have proved beneficial to many manufacturers. Why not ask a Torrington engineer to help with *your* next problem?

THE TORRINGTON COMPANY

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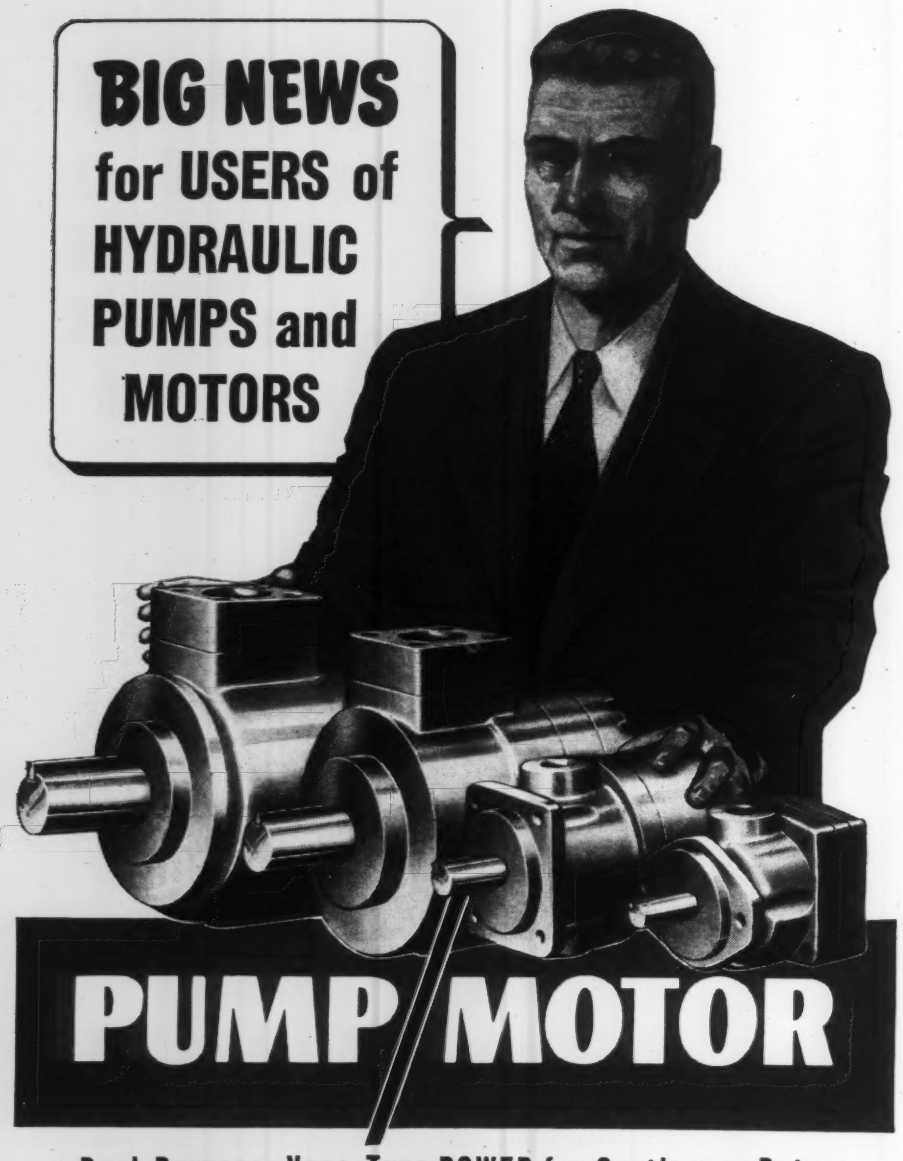

Dual-Purpose, Vane-Type POWER for Continuous Duty

Here's the kind of rugged, low-cost, long-service hydraulic power you've been wanting! Offering complete hydraulic balance of *both vanes and rotors,* this unit assures a dependable performance. Interchangeable cam rings — available for each of four sizes — provide eleven different models. Adaptable for either clockwise or counter-clockwise operation. Denison Pump/Motors are ready for use as either pumps or motors without alterations of any kind . . . built for hard, continuous duty at pressures up to 2000 psi. Pumping capacities range from 2½ to 70 gpm. Torque ratings for motor applications range from 13 to 257 inch-pounds per 100 psi. Wide variety of combinations possible for any porting requirement. Choice of mounting arrangements including CIMTC standards. Get full details on Denison Pump/Motors; write today for Bulletin P-5!

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of his personal ineffectiveness. He is the man who says nothing in a conference, composed of either his co-workers or his superiors. Keeping one's mouth shut might give a reputation for wisdom but perhaps observation of others might parallel this poorly quoted axiom from a forgotten source: " 'Tis better to say nothing and be thought a fool than to open the mouth and dispel all doubt."

When a conference is called for the purpose of making a decision and the engineer who should know something refrains from saying a word, he naturally contributes nothing!

The boss fidgets. He knows what's coming. "J. P., why did you hire that dumb cluck?" Just try to get a raise for the silent engineer the next time you think he's due for one!

—J. P. HENDERSON

Besides missives from Henderson, stress reliefs in other forms are brought to our desk by the mail. One this month is quite profound in approach . . . let us quote . . . "I realize that to be an apostle of the metric system would be too great a job for an individual, but I would like to see interest revived in this subject. At this time, I do not want to engage in a lengthy thesis on this matter. I am only enclosing a carbon copy of a letter which I sent to a fellow engineer in Europe. This letter is written from my own American viewpoint. It is, as you find for yourself, clear and concise and contains all scientific basis for a full understanding of the subject." Here's the letter:

Dear Joseph:

During my last visit at your engineering department, I had an occasion to study the metric system which you are using and I can clearly see now what advantage our measuring system has compared with yours.

You measure a thing in meters regardless of whether you measure up, down or sidewise; you weigh it by kilograms regardless of whether it is light, heavy or tremendous; and for cubic measure, one kilogram of water is always a liter.

How much more concise our

SO HIGH A FINISH...

you can almost see the finished products

NEED CYLINDER PARTS? New Rockrite Tubing comes with so high an inside finish that it is ready to go to work as hydraulic cylinders, shock absorbers and similar parts. Smooth, scratch-free inner surface requires *no machining* when used with leather or other soft packings. Only a light honing is needed for metal piston rings.

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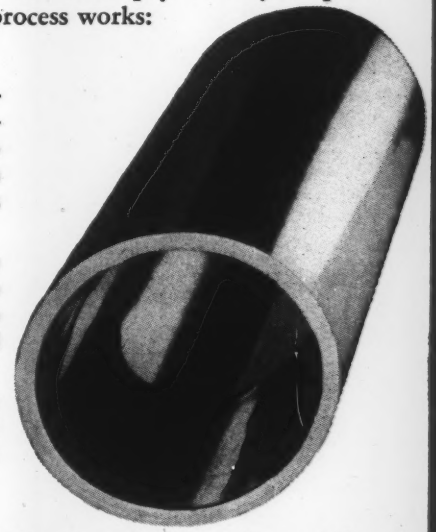
- **Dies compress the metal against a mandrel, tending to iron out small irregularities on both the inside and outside surfaces. The metal flows from high spots in the same manner as when it is forged.**
- **A certain amount of planishing action also takes place on the inside surface of the tube as it elongates under the pressure of the dies and creeps forward while in contact with the mandrel.**
- **In no part of this operation is there any action which can produce longitudinal scratches. The metal is not drawn through a die and over a mandrel.**



SIZES? Rockrite cylinder-finish tubing comes in bores from 1½" to 5½", depending on wall thickness. Get additional facts and figures from Joseph T. Ryerson & Sons Company, Chicago, national warehouse distributor, or write us direct.

ROCKRITE saves more than any other tubing

- **Higher cutting speeds**
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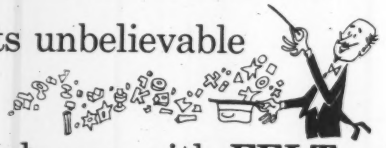

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...or as tough and hard as a loan shark's heart.

We will make it for you in any color or shade in the full range

from black to white.

You can order it in any thickness, any consistency, any size,

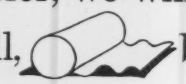
any shape.

We will cut it for you to meet your most exacting

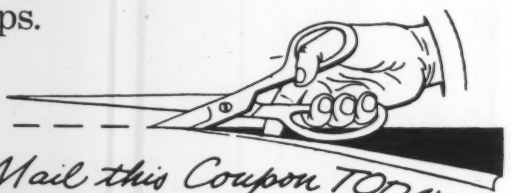
size-and-shape requirements.

Or, if you prefer, we will ship it

to you by the roll,



by the square yard, or in strips.



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American system of measurement is I shall explain to you, for I have studied it long and I know it well.

When measuring on land, we use miles, on the water we measure by nautical miles, which are not the same as statute miles, or we may use leagues, but only when measuring straight out, for downwards we use fathoms, unless we prefer cables. But rope is measured by yards, unless you want to use feet, but why not use inches, or better yet use them all at once. There are many inches to a mile, but how many is a military secret and if you would try to figure it out, you would be wrong anyway, for of course I meant the other kind of a mile. But for weight we use pounds only, unless we prefer to use ounces, and don't try to find how many ounces to a pound, for there are various types of ounces and you are destined to get the wrong one. And ounces are not used anyway, for we use grains, unless we want to use pennyweights, which is not the same as an avoirdupois ounce, but also has nothing to do with a fluid ounce, which really, is some part of a gallon, no, a quart, which contains several pints, I mean, it's a fraction of a ton, a long ton, of course, but no, I said short tons, which differ by so many pounds and are not the same as register tons, in fact it is really a bushel, and there is a law in Pennsylvania, which dates back to the Civil War and says that one bushel, I mean one heaped bushel, no pardon me, one struck bushel, when added to four gallons, that is to say, rather just as many gills, no, imperial gallons, not U. S. gallons, which really should be seventeen and fifteen thirty-second hogsheads, no fluid drachms, no, furlongs, but please don't get me all mixed up, I had it all quite clear: I was talking about the number of barrels, rather pennyweights, but no, links, no, fathoms, ounces, gallons, hogsheads! Help. . . .

—A Forlorn Metric Devotee

We'll not additionally identify Joseph's friend, but we assure you that his command of weights and measures is exceeded by the authority with which he treats design problems from time to time in our main editorial pages.

WHEN METAL PARTS MUST BE STAMPED OR DRAWN...

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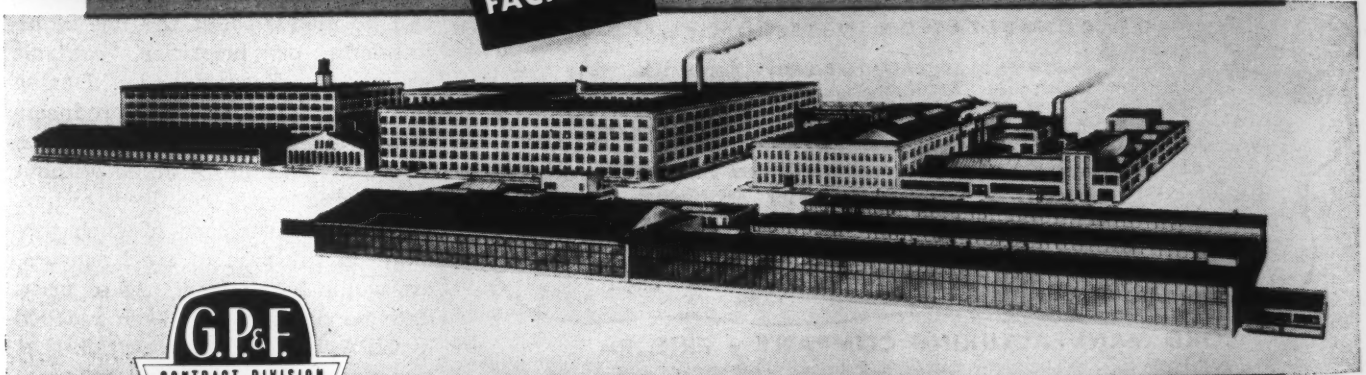

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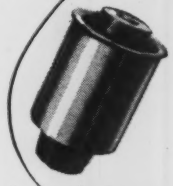

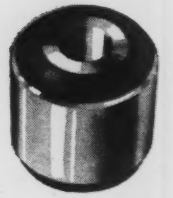

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REPORT ON

Materials

SECOND-QUALITY carbon steel will be decontrolled for the fourth quarter of 1952—releasing about 800,000 tons per quarter. This is the second ferrous metal released by NPA under its "relaxed" controls policy. Although the new category mainly includes shearings from sheet and strip steel, this action is but one more indication of the complete decontrol action hoped for near the end of the year.

The steel industry has already proposed one plan to NPA which, in effect, provides for retention of controls during the fourth quarter of 1952 as a trial period, after which limitations would be removed if no serious disruption of the nation's economy shows up. Basically, the Steel Products Advisory Committee plan calls for continuance of controls on prime steel products to assure the complete fulfillment of military and atomic energy steel requirements. Converters and warehouses would also receive a fair, controlled share of steel. Steel consumers using over a minimum tonnage would be limited to a certain percentage of their highest quarterly receipts during the nine months from October, 1951, through June, 1952, and certain construction projects would be limited.

When it becomes apparent that Defense Department and Atomic Energy Commission requirements can be met without the use of allotments or priorities, controls would be discontinued. During the interim period, steel producers would be allowed to ship unrated orders if possible to do so without interfering with required orders, and unrestricted use of such tonnage on the part of steel consumers would be allowed. As of press date no decision had been reached by NPA, although it is certain that serious consideration will be given to the plan.

Small Metal Users: The self-authorization procedure under

CMP Regulation 1 which permits certain manufacturers to obtain controlled materials without filing CMP-4B forms has again been liberalized. As of the third quarter of 1952, any manufacturer of a product listed on the Official CMP Class B Product List may use the self-authorization procedure to obtain controlled materials up to the following limits per quarter, provided that the average quarterly consumption of controlled materials during 1950 is not exceeded:

Carbon steel	60 tons
Alloy steel	16 tons
Stainless steel	500 lb
Copper and alloys	3000 lb
Aluminum	4000 lb

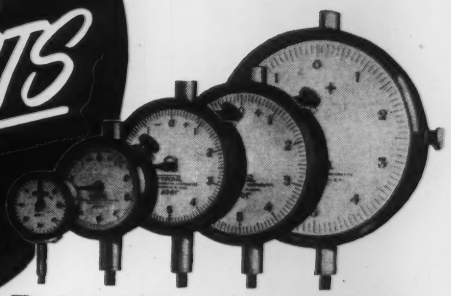
These manufacturers may instead choose to self-certify, regardless of the base-period 1950 consumption, up to the following quantities:

Carbon steel	25 tons
Alloy steel	1 ton
Stainless steel	none
Copper and alloys	500 lb
Aluminum	1000 lb

Consumer Durable Goods: Greater flexibility in shifting controlled materials from one product to another is possible through an amendment of the consumer durable goods order, M-47B. The first three groups of products listed in this schedule have been combined into one large group, allowing manufacturers to shift allotted materials from a product in falling demand to one in rising demand within a quarter, if both are listed. The action was taken to counteract the effect of low second-quarter allotment levels which, according to G. Harrison Echols, administrator of the order, were the lowest expected for consumer durable goods.

Alloy Castings: High-alloy castings for high-temperature and corrosion-resistant service are presently limited by NPA Order M-80, Schedule C, which places maximum limits on the nickel and nickel-chromium contents for various temperature zones. Research now being conducted at the Battelle Memorial Institute for the Alloy Casting Institute is directed at finding substitutes for these materials in the intermediate temperature range of 900 to 1400 F. An

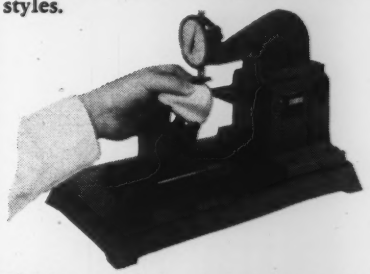
Gage Making is a Job for SPECIALISTS



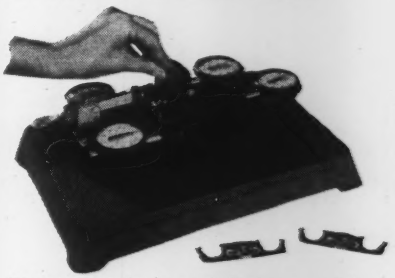
Dial indicators for every gaging requirement — over 80 different models, ranges, sizes, graduations, styles.

There's no true economy in designing and building your own dimensional gages. Consider the hours wasted in painstakingly developing by trial and error a gage to duplicate one of the 25,000 already in our files. "Homemade" gages, even when built with precision, can be liabilities — not only costly in their making but often inefficient in their performance on the job. Gage making, experience shows, is a job for specialists!

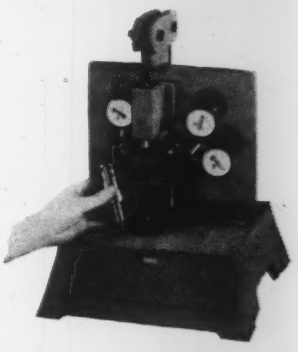
Federal Dimensional Indicating Gages are designed and built by men whose experience cannot be equalled anywhere in the world. Over 25,000 gage designs are readily available in our files. One of them, or an adaptation of it, is almost certain to answer *your* problem. Bring your gaging needs to Federal and take advantage of our engineering experience. We will work closely and confidentially with you on your dimensional gaging requirements. Send full details and blueprints to Federal Products Corporation, 1306 Eddy Street, Providence 1, Rhode Island.



Thickness of insulation cone is checked throughout its length.



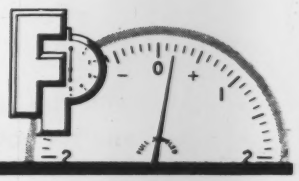
Location of central hole — with reference to two other critical location points — is inspected for accuracy on this metal stamping.



This gage accurately and simultaneously sets three tool bits on a boring bar used for high production boring.

FEDERAL

Largest manufacturer devoted exclusively to designing and manufacturing *all types* of DIMENSIONAL INDICATING GAGES



AMERICAN CHEMICAL PAINT COMPANY

AMBLER CHEMICALS ACP PROCESSES PENNA.

Technical Service Data Sheet

Subject: HOW TO MAKE PAINT STICK TO GALVANIZED IRON WITH LITHOFORM®

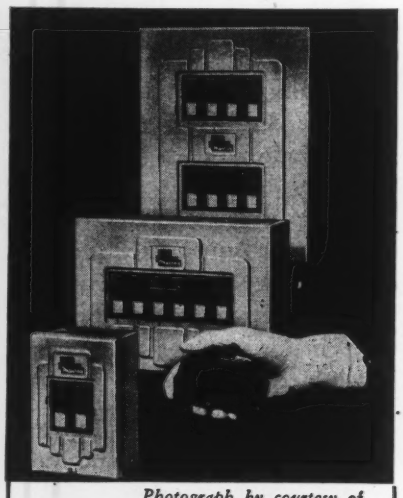
INTRODUCTION

"Lithoform" forms a dense, zinc phosphate coating on zinc, cadmium, and galvanized surfaces—including Galvanneal, cadmium plated steel, zinc plated steel, zinc base alloys, and zinc base die castings. The "Lithoform" coating, which is non-metallic and inactive, retards reaction between alkaline metal oxide and the paint film. Peeling and loss of adhesion are thus greatly retarded on painted Lithorized zinc and cadmium.

ADVANTAGES OF "LITHOFORM"

"Lithoform" forms a durable bond for paint. It is economical. It eliminates frequent repainting. It protects both the paint finish and the metal underneath. "Lithoform" meets these Government Finish Specifications:

QQ-P-416
RR-C-82
MIL-E-917A (Ships)
JAN-F-495
AN-F-20
U.S.N. Appendix 6



Photograph by courtesy of Murray Manufacturing Corp.

Murray Circuit Protectors are fully magnetic and provide maximum protection for both domestic and industrial wiring. Housings are of galvanized iron which is Spray Lithorized for long paint life.

THE LITHORIZING PROCESS

"Lithoform" can be applied by brushing or spraying the work with simple hand equipment, by dipping it in tanks, or by spraying it in industrial power washers.

Brush. Galvanized bay windows, cornices, rain gutters, hardware, building siding, truck panels, and farm equipment are typical of the many surfaces that are treated effectively with Brush "Lithoform".

Dip. This grade is used for coating cleaned surfaces of such typical products as cabinets, refrigeration condensers, etc., immersed in heated solutions in tanks.

Spray. The spray process is the most logical one with which to coat sheets, coiled strip or duplicate products best processed on a conveyor.

CHEMICALS ACP PROCESSES

WRITE FOR FURTHER INFORMATION ON "LITHOFORM" AND ON YOUR OWN METAL PROTECTION PROBLEMS.

CHEMICALS ACP PROCESSES

alloy containing 21 per cent chromium and 9 per cent nickel is currently being investigated. Designated as the HF type, this alloy was formerly disregarded for heat-resistant service—probably due to the fact that wrought stainless steels having approximately the same composition did not prove as satisfactory as high alloy castings. Tests now being made indicate that the cast HF alloy has strength properties comparable to the higher alloyed cast grades at these intermediate temperatures. The lower nickel content brings this casting material within the limits imposed by the NPA order for many types of service.

Major Rubber Control Ended: With the removal of specification controls limiting the amount of natural rubber that may be used in rubber products, ten years of rubber controls have virtually come to an end. Although certain restrictions still exist, the net effect of the revocation of NPA Order M-2 is to provide relatively free competition between natural and synthetic rubber. Government rubber-producing facilities are expected to be "maintained at a level sufficient to provide for national security" without mandatory controls but standby specifications for the mandatory consumption of GR-S and Butyl will be kept in reserve should consumption fall below levels sufficient to maintain synthetic rubber production. According to P. W. Litchfield, chairman of Goodyear, these won't be necessary, since he forecasts a coming shortage following the present period of plenty, and urges expansion of the nation's synthetic rubber industry and plantings of natural rubber in the Western Hemisphere as the first steps in a program to meet the anticipated situation.

List of Basic Materials: Released on April 30, the sixth issue of the NPA *List of Basic Materials and Alternates* points out a marked easing in all categories except metals and miscellaneous items. Lead and zinc are in better supply, but the addition of low-alloy steel castings and heavy carbon-steel castings to Group I counteracts this tendency. Little change is noted

SILICONE PROGRESS

Broaden operating range— Because G-E silicone rubber remains flexible from —85 to 500 F, when used in this mount, it effectively isolates delicate aircraft and industrial instruments from shock and vibration.

Courtesy Lord Manufacturing Company

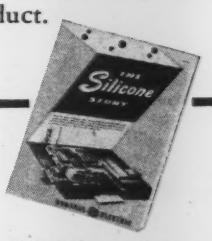
Specify GE Silicones to isolate vibration

4 BASIC PROPERTIES

OR SOLVE OTHER TOUGH JOBS FACING YOU

Isolating vibration at extreme temperatures is just one of the many unusual applications for G-E silicones. Flexible silicone rubber hot-air ducting is used in aircraft. Silicone resins in Class H insulation permit motors to run hotter and longer, reducing breakdown and rewind costs. Silicone fluids prevent railroad steam couplings from sticking. Silicone rubber provides primary insulation for high temperature ignition wire. Water repellent silicone resins stop spalling and cracking of masonry.

Where can you use the unusual properties of G-E Silicones to reduce your costs, speed production, or improve your product. Perhaps even create a new product.



Section 131-3 B
General Electric Company
Waterford, New York

Please send me free copy of the complete G-E Silicone Story

Name.....

Street.....

City..... Zone..... State.....

(In Canada, mail to Canadian General Electric Company, Ltd., Toronto)

GENERAL ELECTRIC

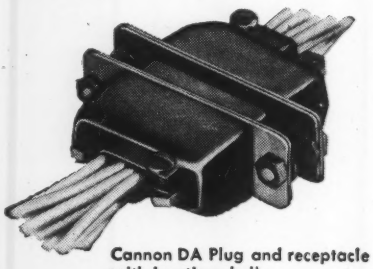
131-3

the new sub-miniature

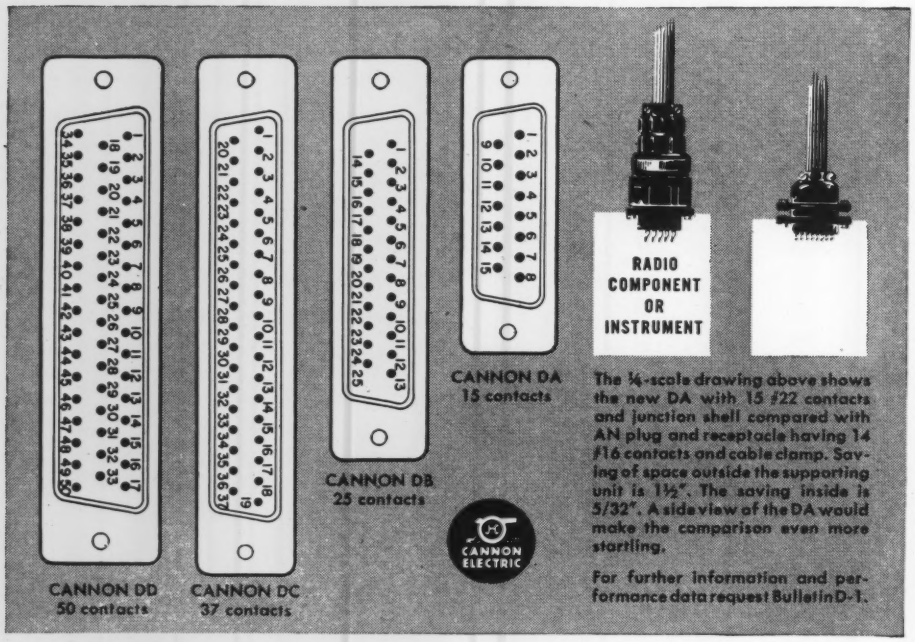
tiny but rugged

Series D Cannon Plugs satisfy a long felt need of the Electronics Industry for a sturdy, versatile and extremely compact connector for use on miniaturized equipment of all kinds. These may be mounted as (1) rack and panel (2) box (3) wall, or (4) cord connectors. Junction shells with integral clamps protect the terminal ends of the connector when used as cord or wall mounted units.

Contacts are of the quality you expect to find in any Cannon Plug. Machined from copper base alloy, gold plated, they accommodate #20 or #22 AWG stranded wire. Rated capacity 5 amps. High dielectric insulators. Minimum flashover, 1000 volts rms. The protective steel shells provide an integral mounting flange. The "keystone" shape of the shells gives positive polarization with friction type engagement.



Cannon DA Plug and receptacle with junction shells.



The ¼-scale drawing above shows the new DA with 15 #22 contacts and junction shell compared with AN plug and receptacle having 14 #16 contacts and cable clamp. Saving of space outside the supporting unit is 1½". The saving inside is 5/32". A side view of the DA would make the comparison even more startling.

For further information and performance data request Bulletin D-1.

CANNON ELECTRIC

SINCE 1915. Factories in Los Angeles, Toronto, New Haven, Benton Harbor. Representatives in principal cities. Address inquiries to Cannon Electric Company, Dept. F185, P.O. Box 75, Lincoln Heights Station, Los Angeles 31, California.

among the miscellaneous items, except for rubber, which has eased.

The following partial list supersedes the one published in MACHINE DESIGN, April, Page 262.

Metals—Group I-A
(In short supply)

a—Nonferrous:
- *Aluminum
- *Beryllium
- *Copper
- Magnesium
- *Selenium
- *Titanium
- *Tin

b—Precious:
- Iridium
- Osmium
- *Platinum

c—Ferrous alloying elements:
- *Cobalt
- *Columbium
- *Molybdenum
- *Nickel
- *Tantalum
- *Tungsten

d—Ferrous:
- Bars, cold drawn:
  - Alloy
  - *Carbon steel
- Bars and semifinished, hot-rolled:
  - Alloy
  - *Carbon steel
- Castings:
  - Carbon steel
  - *Carbon steel, heavy, over 3,000 pounds
  - Low alloy steel
  - *Gray iron: Heavy, over 3,000 pounds
  - *Gray iron alloy: Heavy, over 3,000 pounds
  - Steel, high alloy:
    - Corrosive-resistant
    - Heat-resistant
- Die blocks
- Forgings, heavy
- Iron powder
- Pig iron, low phosphorus
- Pipe:
  - Seamless, all sizes
  - Welded:
    - 4 inches and over
    - 3 inches and under, galvanized
- Plates
- Rails
- Shapes, structural
- Sheet, galvanized
- *Stainless steel: Nickel bearing
- Strand wire, galvanized
- *Tubing, seamless:
  - Alloy mechanical
  - Alloy pressure
  - Carbon, mechanical
  - Carbon, pressure

Metals—Group II-A
(In approximate balance)

a—Nonferrous:
- Calcium
- Germanium
- Zinc (galvanizing grades)

b—Precious:
- None

c—Ferrous alloying elements:
- Chromium
- Manganese
- Silicon
- Vanadium

d—Ferrous:
- Forgings, medium
- Pipe welded: 3 inches and under (except galvanized)
- Pig iron (other than in Group I)
- Plate, tin
- Rods: Hot rolled
- Sheet: Cold rolled
  - Hot rolled
- Strip: Hot rolled
- Wire, drawn: welding, quality

Metals—Group III-A
(In fair to good supply)

a—Nonferrous:
- Antimony
- Bismuth
- Cadmium
- Lead
- Mercury
- Tellurium
- Zinc: High grade
  - Special high grade

b—Precious:
- Gold
- Palladium
- Rhodium
- Ruthenium
- Silver

*Most critical.

c—Ferrous alloying elements:

Boron
Ferrotitanium
Zirconium

d—Ferrous:

Castings:
Gray iron alloy, light-weights
Gray iron (light and intermediate weights)
Iron malleable
Forgings, small
Plate, tin mill black
Stainless steel: Straight chrome
Strip: Cold rolled
Tool steel
Tubing, welded: Carbon, mechanical
Wire, drawn (other than in Groups 1 and 2)

Chemicals—Group I-B
(In short supply)

Alkyl phenols
Alkyl phenol resins
*Alkyl polysulfide polymers
Butadiene
Monochlortrifluorethylene
Polyethylene resins
Selenium compounds

Chemicals—Group II-B
(In approximate balance)

Alkyd resins
Melamine resins
Polyester resins
Resorcinol resins
Styrene

Chemicals—Group III-B
(In fair to good supply)

Cellophane
Cellulose acetate
Cellulose butyrate
Ethyl cellulose
Methacrylate
Nylon, plastic type
Polystyrene
Polytetrafluorethylene (Teflon)
Polyvinyl acetate
Polyvinyl alcohol
Polyvinyl butyral
Polyvinyl chloride
Urea resins

Miscellaneous—Group I-E
(In short supply)

Asbestos:
Amosite
Chrysotile:
Crude and spinning fibers
Shingle fibers
Graphite, natural:
Crucible flake
Ceylon: High carbon amorphous lump
Mica:
Muscovite block and film, good stained and better
Bookform splittings
*Rare earths
Rubber:
Butyl (GRI)
Natural, dry:
Pale crepe, all grades
Sole crepe
Talc, Indian block, lava grade

Miscellaneous—Group II-E
(In approximate balance)

Abrasives, synthetic:
Aluminum oxide
Silicon carbide
Graphite, artificial: Electrodes, anodes and special shapes
Mica:
Phlogopite, splittings
Muscovite block and film (lower than good stained)
Muscovite splittings, loose
Quartz crystals (MBS grades I and II)
Rubber:
Natural, dry (other than in Group I)
Synthetic (GRS), cold
Talc: Ground, including steatite

Miscellaneous—Group III-E
(In fair to good supply)

Asbestos, Chrysotile: Shorts and waste fibers
Paper
Paperboard
Rubber:
Natural, latex
Reclaimed
Synthetic (GRS) other than cold

Copies of the latest *List of Basic Materials and Alternates* may be obtained from the nearest district or regional office of the Department of Commerce or by writing Printing Services, Department of Commerce, Washington 25, D. C.

An entirely new principle of bearing construction! RBC's PITCHLIGN cage keeps the rollers in perfect alignment by contact at the roller *pitch circle*. Rollers cannot cock or skew!

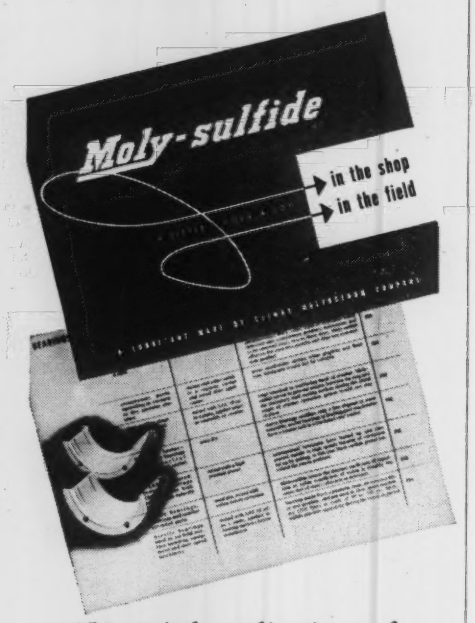
Internal stresses are reduced to an absolute minimum in PITCHLIGN bearings because the cage acts *only* in the direction of rotation at a point coincident with the roller orbit. Again, accumulated tolerances or wear of load carrying surfaces have no effect on the overall efficiency of the cage, since it is supported by the two integral flanges of the heavy outer race.

PITCHLIGN is not merely an improvement on a standard type bearing—it represents an entirely *new concept*, developed in an entirely new product . . . dimensionally interchangeable with precision needle bearings.

PITCHLIGN's performance potential can save you time and money. Get The Facts!

Write Today **Ask for Bulletin SF-266**

154 ideas on ways to use...



154 varied applications of molybdenum sulfide in the shop and in the field are described in a new booklet now available. This solid-film lubricant has demonstrated unique anti-friction properties under conditions of extreme pressure, high velocity, elevated temperature, or chemical attack.

The 40-page booklet contains the records of solved lubrication problems — some might solve your own.

Moly-sulfide
A LITTLE DOES A LOT

The lubricant for extreme conditions

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New York City 36, N.Y.

Please send me your Free Booklet

Name.....
Position.....
Company.....
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MOLY

MD-6 MS-6

Design Abstracts

(*Continued from Page* 130)

quently set up for a problem of average complexity in less than five man-hours. By virtue of this feature and also the low first cost, these machines should be employed for simpler problems, including many which mathematicians now solve with desk calculators.

The characteristics which place a limit on the complexity of problems to which any given machine should be applied are:

1. Initial cost
2. Setup time
3. Time required for analysis of results.

The third consideration, not heretofore mentioned, is a consequence of the character of solutions presented by these machines. The oscillograph or plotting table picture requires interpretation to make it quantitative and fully meaningful. To men who use such devices continuously, this interpretation process becomes second nature. Still, to make answers fully numerical in a form suitable for reporting, some time must be spent upon the solution records. This time, and the setup and checkout time, constitute the principal operating costs of the simulator.

From a paper entitled, "Engineering Uses of Analog Computing Machines," presented at the ASME Spring Meeting in Seattle, Wash., March, 1952.

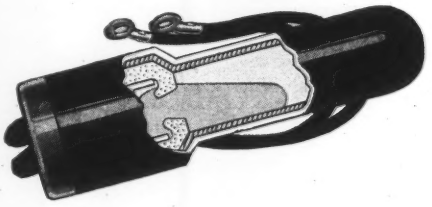
Undergraduate Machine Design

By J. P. Vidosic
Professor of Mechanical Engineering
Georgia Institute of Technology
Atlanta, Ga.

PROFESSORS seem to disagree with regard to the subject matter that should be contained in a well organized course in undergraduate machine design. Some believe it should be highly theoretical, others feel that practice and empiricism should be strongly favored. A look at the texts that have been used in, say, the last twenty years, reveals this variety of opinion. Analyze these texts

Millions of Contacts without Faltering

PROVED ON rough, tough jobs



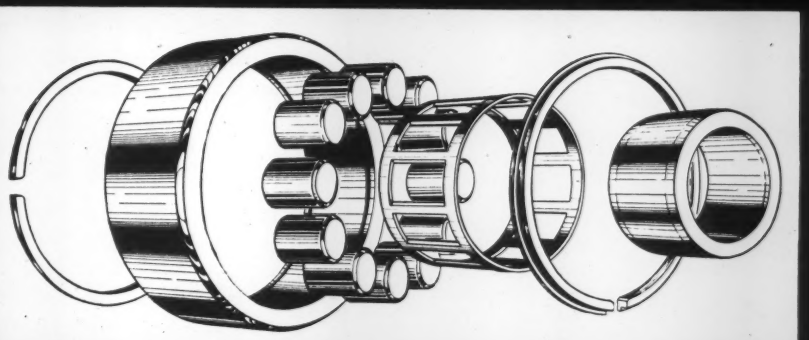
Durakool pressurized all-steel **mercury tilt switches** have more than made good on what may have seemed like extravagant claims a few years ago. The list of Durakool successes grows each year. Seven sizes, 1 to 65 amperes. 3 to 4 weeks delivery. Your production schedule is met.

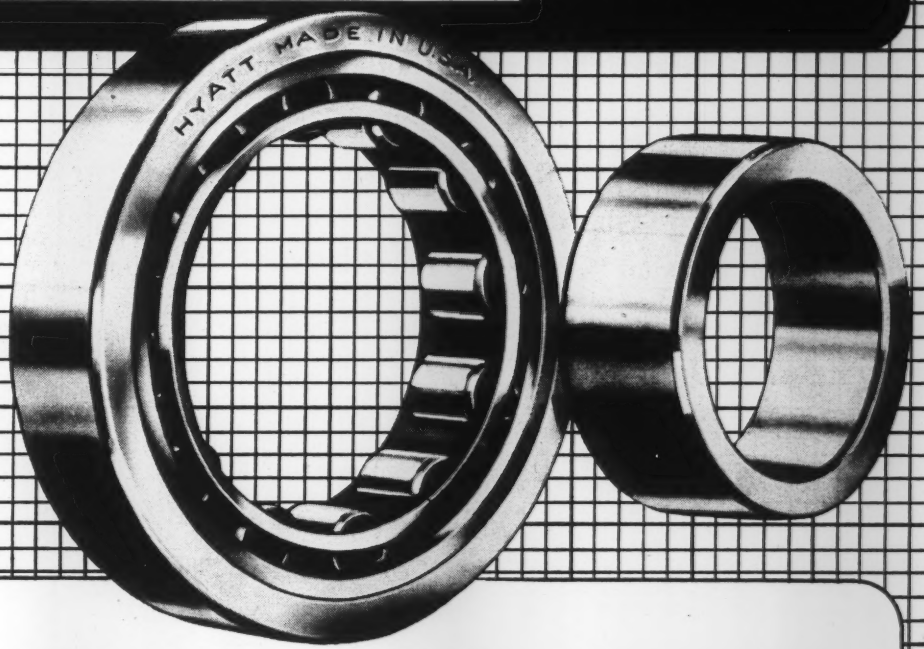
WITHSTANDS HIGH TEMPERATURES

See telephone directory for local distributor or write
DURAKOOL, INC., Elkhart, Indiana

Durakool
ALL-STEEL MERCURY SWITCHES

HYATT HY-LOADS . . . for Capacity Separability and Long Life





IN THE family of Hyatt Hy-Load Roller Bearings is the popular A-TS type, one of the separable inner race, high-capacity cylindrical roller bearings made in two diameter series, wide and narrow widths, to standard boundary dimensions.

Separable parts are freely interchangeable. Any inner race will fit any roller assembly of the same piece number, permitting non-selective fitting after preassembling the two bearing parts in separable machine elements.

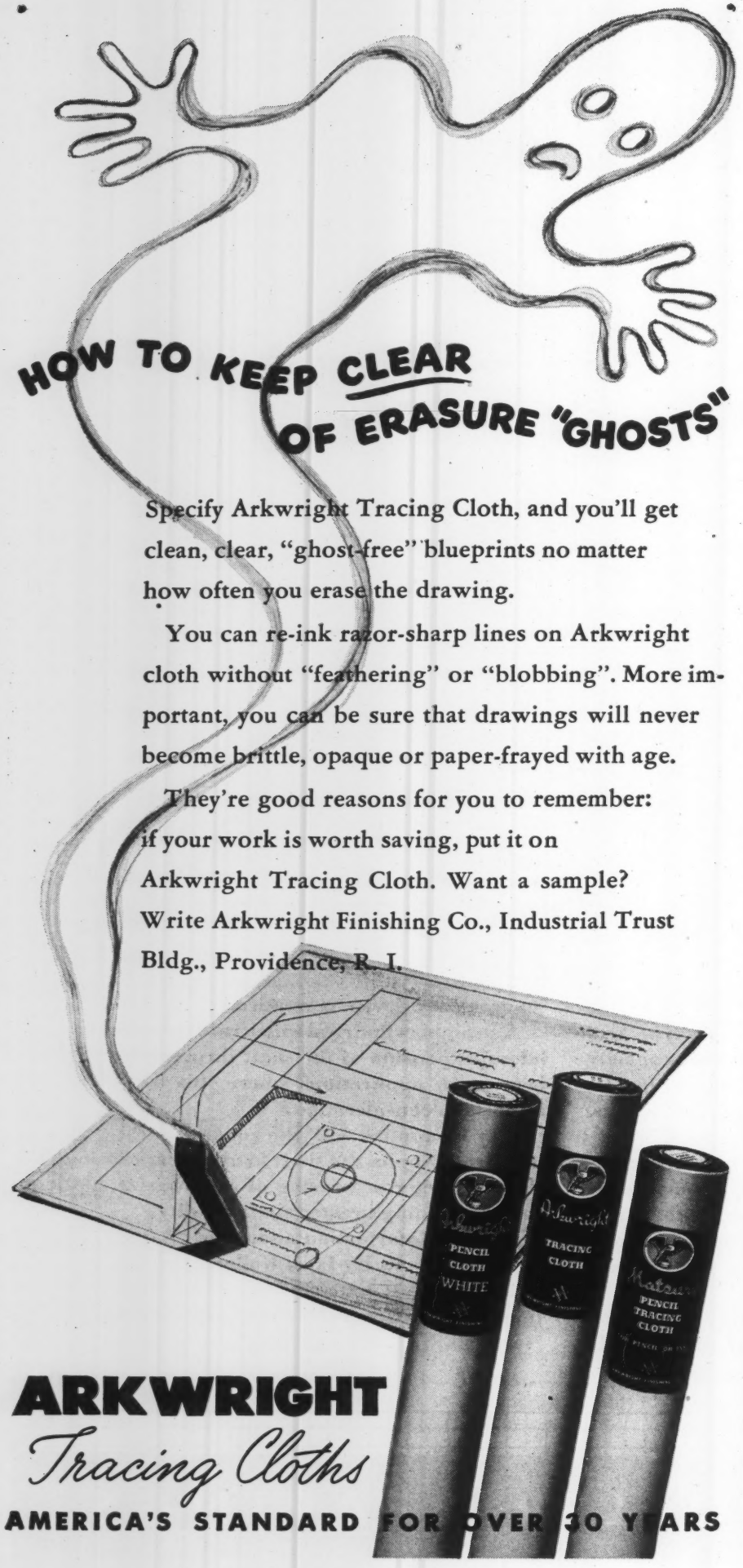
Interference fit of the inner race makes it virtually an integral part of the shaft. No accessory device is required to hold it.

A straight cylindrical inner race permits lateral expansion of the shaft through the bearing in applications where this is an important consideration.

May be applied with the rollers operating directly upon the shaft to utilize larger shaft diameter or bearing of smaller size, thereby gaining greater shaft rigidity.

For full information about the "A-TS" and other Hyatt Hy-Load Roller Bearings, write for Hyatt Catalog 547. Hyatt Bearings Division, General Motors Corporation, Harrison, N. J.

HYATT ROLLER BEARINGS

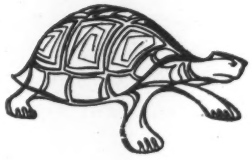


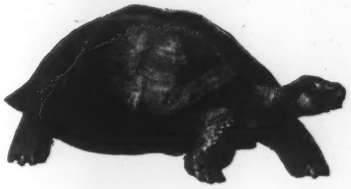
and you are likely to find a range, all the way from practically pure empiricism to practically pure theory. Talk to the practicing designer and you may be disregarded as an impractical "book teacher". What then is the proper course to follow? What should we teach, fundamentals or practice, strength of materials or machine elements, design or selection?

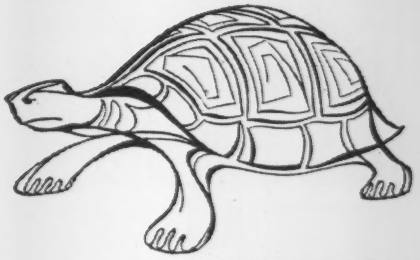
In my opinion, we should emphasize application of theory and devote only what time remains to empiricism and practice. After all theory is more teachable than experience. Furthermore, and most important, is the fact that engineering problems are changing daily. What was needed to design the automobile with a top speed of forty miles per hour is quite different from what is needed to design today's automobile travelling at twice that speed, or the airplane at ten or more times that speed, or the rotor of a supercharger revolving at 30,000 revolutions per minute, or the atomic energy engine of tomorrow, or even the multiple-operation production machines of today. There is only one good way to tackle new problems and that is to start with the fundamentals.

Review Basic Courses

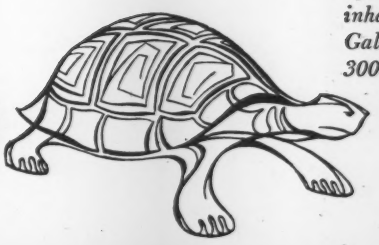
We should start the machine design course with a thorough "review" of mechanics and strength of materials. A review, if it must be so labeled, in which the limitations and proper application of fundamentals to design of machine parts is expounded. The problems here undertaken would not be "academic" but would have all the "teeth" in them—as the student sometimes puts it, so illustratively, "Given nothing; find nothing." After all engineering is actually very nearly that. Since, to design a part, we must first know the forces acting, we should probably start with application of the equations of equilibrium. In this work the student should learn that often we are not certain of the forces for which we design the part. Next we should probably review dynamics, considering conditions such as in a connecting rod, where stresses are continuously varying. This should then introduce fatigue







• *No other member of the turtle family (in fact no other living creature) can match the life expectancy of the species inhabiting the waters of the Galapagos Islands. Average life: 300 to 400 years.*



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In the field of bearings, too, looks can be misleading. Don't buy them on the principle that "look-alikes" must necessarily "last-alike."

Safer way is to look for the name AETNA on the bearings you buy for replacement in the equipment you use—to specify AETNAS when blueprinting a brighter future for the equipment you make. Indicative of their quality and lasting serviceability is the fact that 80% of our business comes from firms we have served for 20 or more of our 36 years.

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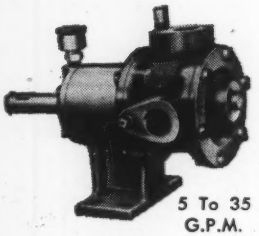

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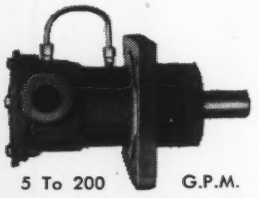

5 To 200 G.P.M.

Ask for free bulletin 303H

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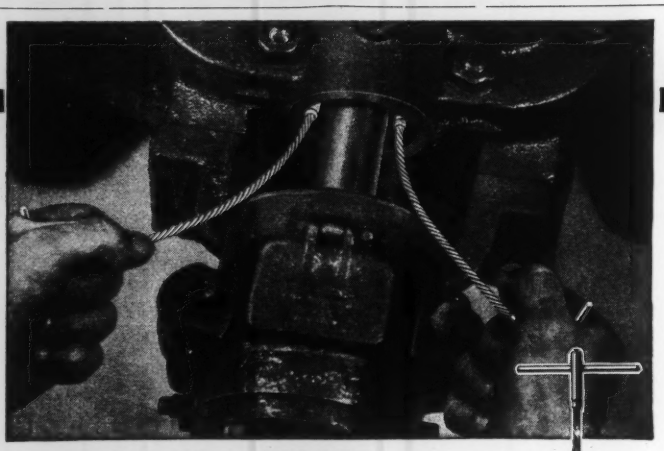

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loads, stress concentration, and impact. Next, should be the practical use of theories of strength in the safe and economical design of machine parts.

Elastic deformation under load can now be investigated. Unfortunately this phase is often neglected; yet in some design, machine tools for example, it is the criteria. Therefore, consideration should be given to elastic curves—deflection, strength, contraction—in statically determinate as well as indeterminate cases. Parts which must comply with deformation requirements would be designed.

Theory Needs Guidance

Problems are bound to arise in which theory fails to give a complete answer. These will serve to introduce the need for and value of empiricism, and experience. Empirical equations should not be freely resorted to; instead the student should evaluate as theoretically as possible the required dimensions to satisfy some requirements and then be guided through modifications based on practice, economy and appearance. This should be performed cautiously with reason and engineering judgment. Anyone can overdesign but only a good designer has the ability to make it just strong enough. The American machine designer has probably strayed in this respect because waste of material has often been a less important feature. On the other hand, the aircraft designer, because of the importance of weight elimination, considers his design sucessful when it fails at say 98 per cent of the design load rather than over 100 per cent—he then knows the weak areas that need strengthening.

Completing the subject of machine design proper we can proceed to the machine elements commercially available. It should be explained that if the student holds a position with a gear, a bearing, or a spring manufacturer he may have to be particularly well versed in design of these elements. However, this explanation would be undertaken only partially. The student has been exposed to the characteristics of these elements, particularly the basis underlying their design. He has been instructed on

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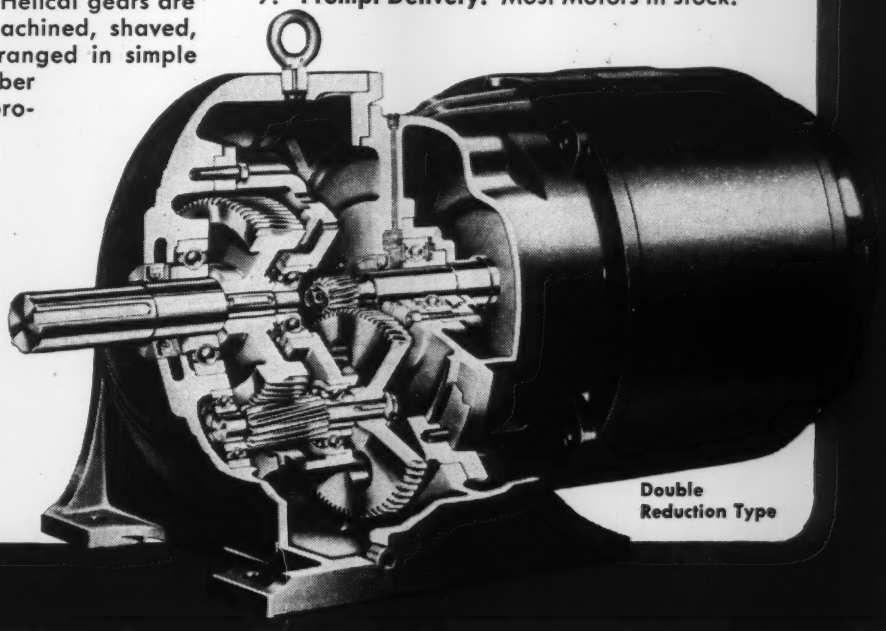

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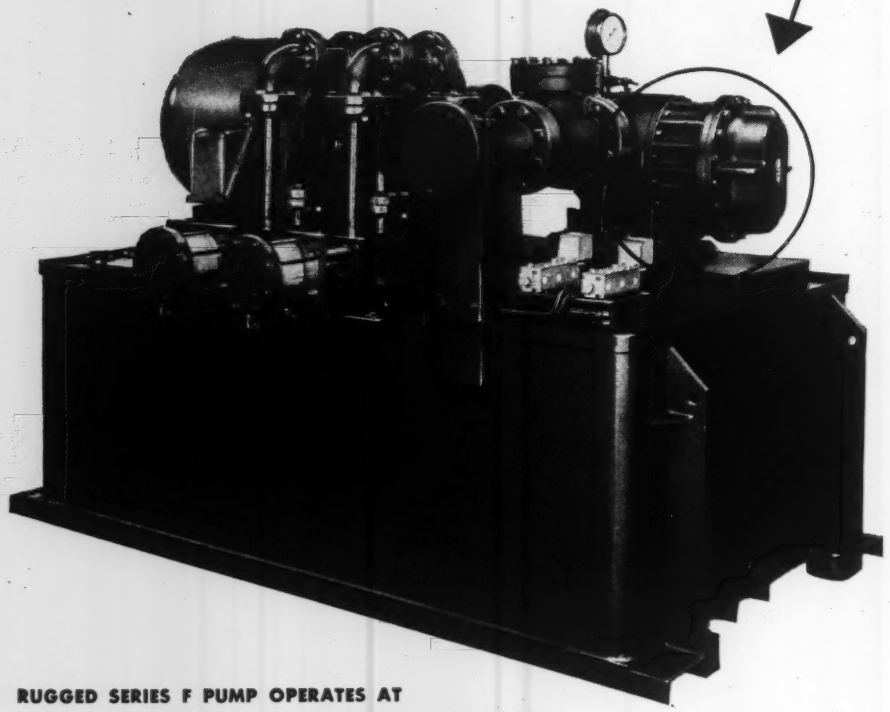

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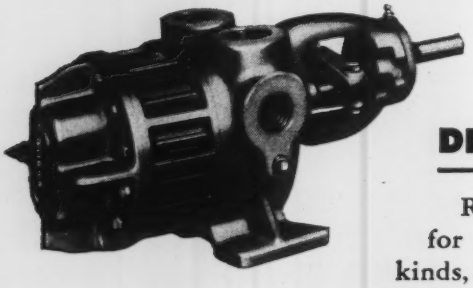
300 P.S.I. ON THIS STEEL MILL PILING EQUIPMENT

This power unit — used in conjunction with steel mill piling equipment — is a good example of Roper adaptability to heavy duty hydraulic applications. The unit is fabricated by the Weinman Pump and Supply Company of Pittsburgh, and the Roper used is a Series F.



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their proper selection for the machines that he may be designing.

Thus, the machine design course discussed here would cover the following phases with approximately the percentage of time indicated for each phase:

10%. Force analysis—both static and dynamic
35%. Stress analysis—design for static, fatigue, and impact conditions
20%. Elastic deformation — for parts where the amount of yield is the determining criteria
35%. Study of commercially available machine elements.

The laboratory portion of this course should provide drill periods for topics being studied. For this purpose the projects, probably design of individual machine parts or subassemblies, should follow as closely as possible the topics being discussed in class. In order to reacquaint the student with the important graphical language of the engineer, working sketches of the designed parts should be demanded in all cases. In addition finished detail and assembly drawings of one project performed in acceptable, drafting-room practice should be required.

From a paper of the same title appearing in the March, 1952 issue of the Machine Design & Manufacturing Bulletin published by the ASEE.

Strength of Bolted Assemblies

By John S. Davey

Russell, Birdsall & Ward Bolt & Nut Co.
Port Chester, N. Y.

STRENGTH of a bolted joint depends upon the amount of residual tension left in the bolt after the wrench is removed. Of course, it is always necessary to have a bolt strong enough to carry the required loads, but in addition the factor that makes a joint strong is this residual tension, or preload.

Rigid Joints: In a rigid joint, the tension in the bolt must be greater than any external loads applied. If, for a metal-to-metal connection, the modulus of elasticity approximates that of the steel

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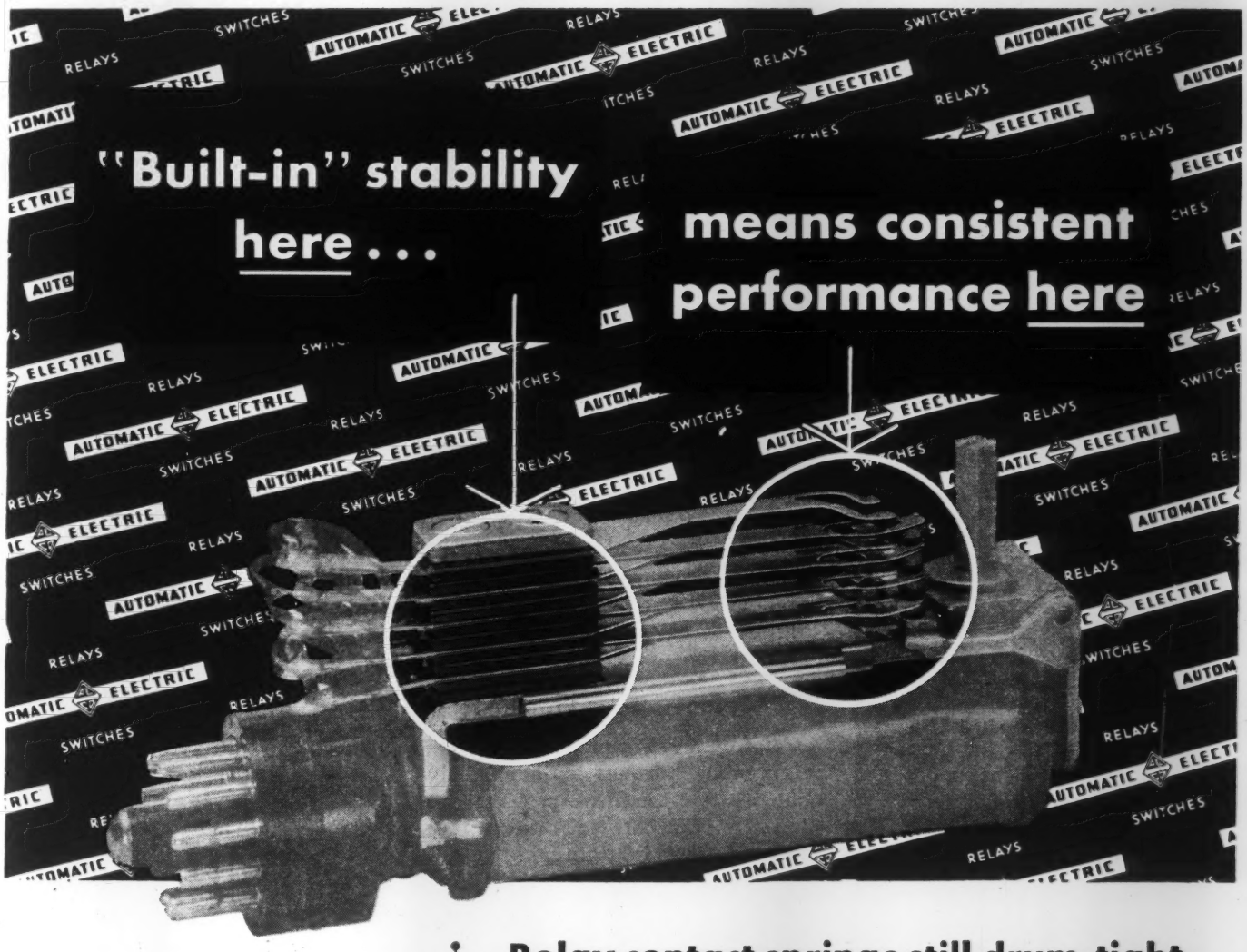
bolt, it may be assumed that there is practically a rigid connection. In such a case, with tightening producing a 1000 lb tension in the bolt, a load up to 1000 lb can be applied to this assembly without causing appreciable loading in the bolt. This preload of 1000 lb must be maintained throughout the life of the joint. Poor quality of surface, burrs, rough castings, paint, foreign matter, brinelling, crushing, or anything which tends to shorten up the grip length between the head of the bolt and the nut and cause the bolt to return to its original length can dissipate this load. When a bolt is tightened it stretches elastically 0.001-inch per inch of grip per 30,000 psi stress—that is, of course, within its elastic limit. As the bolt loses its elongation, it loses its prestress. It will stay tight as long as external loads are within the preload limit; otherwise it may not.

Preload Resists Fatigue

Another advantage of preloading is resistance to fatigue. In fact, if the preload is greater than an applied load, the fatigue life of a bolt becomes infinite. Increased preloading reduces the amplitude of stress change in the bolt to a safe value, provided the bolt material is comparatively rigid. Preloading is also beneficial in providing a locking effect to avoid unscrewing. Excessive amplitude of stress change in a bolt has a tendency to cause the nut to loosen. In a rigid joint it is interesting to note that if the bolt tension is sufficient, the frictional forces exerted on the contracting surfaces will resist shear. There will be no slippage and, therefore, no surfaces in bearing nor metal breakdown by fatigue.

Nonrigid Joints: With a gasket separating the metal surfaces, the external loads are almost entirely added to the preload. Bolts in such joints must be selected to have strength enough to take the preload, plus whatever load is added. A steam chest must have the bolts tightened sufficiently to resist operating forces and to maintain the gasket compression which prevents leakage. While the operating forces do generate



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Step 4—Finally, each completed pile-up is inspected for:

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- *Correct seating of screws*
- *Contact line-up—exact spring spacing*
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- *Staking and correct length of screws*
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WRITE FOR CATALOG

cycle loading, the frequency in this case would not be high enough to cause fatigue or loosening. Some air cylinders used to vibrate foundry equipment also present such bolt problems.

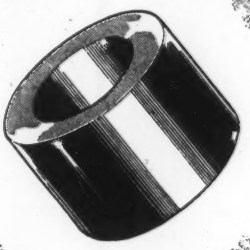
When cycle loading is present the bolt should be strong enough so that the preload, plus the external load, will be below the endurance limit of the bolt. Often the cycle loading is so severe it is necessary to reduce the shank of the bolt below the stress area of the threads to relieve the critical section. It is best, in these cases, to use as long a bolt as possible. Frequently a soft ductile bolt is better than one of high proportional limit. A heat-treated bolt drawn at high temperature would be recommended rather than one of low carbon. Also, a locking device is often necessary to prevent the nut from loosening.

Friction Causes Problems

Tightening Torque: Correct tightening torque is admittedly one of the toughest problems to face. About 90 per cent of the torque effort in tightening a nut is used to overcome friction. This friction factor is so easily changed it is hard to predict the torque necessary to tighten up a bolt. The torque required to produce a given tension in the bolt may be considered as equal to the product of the torque coefficient, the nominal diameter, and the bolt tension. Under normal conditions this torque coefficient is 0.2. But, what are normal conditions? The only way to find out is by setting up a pilot assembly and making actual trials.

Bolt Selection: In selecting the proper bolt, standard sizes should be used; specials are expensive and hard to obtain. Moreover, if there is a field adjustment or repair problem, a special is very impractical. It is safest to go to ASA Standards for dimensions, and recently ASA has even set up product standards. Fastener manufacturers have catalogs showing stock items, and maintain an association, Industrial Fasteners Institute, which is always ready to help engineers. ASTM publishes specifications covering physical proper-

WORKS WHERE OTHERS WON'T



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Cherry Rivets are one of the more than 10,000 types of special and standard devices produced by Townsend Company for fastening metal, plastics, wood, glass and fabrics together economically. This wide selection of fasteners is one reason why Townsend sales engineers are unbiased in recommending the best item for a specific use. For information on how to improve product appearance—reduce assembly time and costs, write your nearest Townsend office today.

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ties and SAE has also compiled various physical grades. Refrain from consulting handbooks that state a ⅝-inch bolt has an allowable load of 400 lb and that no bolt under ½-inch should be used.

Common fasteners are usually 1018 low-carbon steel. This steel does not react to heat treatment and, therefore, can be classed as approximately 55,000 psi tensile. There is also the 1038 heat-treated product, the properties of which are covered by ASTM 325 and SAE grade 5. Although this is considered to be of the 125,000 psi tensile class, sizes above ⅝-inch are slightly below this figure. This class is becoming the popular grade of fastener and, while it is as yet only made as a stock item in the hex-head cap screw, it is being ordered as specials in the other types of bolts.

High Strength Available

Some bolts are being produced from alloy steels of the 150,000 psi tensile class, covered by SAE grades 7 and 8, but these are expensive. Unless there is some special engineering reason that offsets cost, these bolts should not be specified. The 1038 screw is the most economical to use if the joint is engineered to take advantage of its holding power. It withstands more pounds pull per dollar than any other fastener. The common bolt offers more pieces per dollar if the problem is to fill holes.

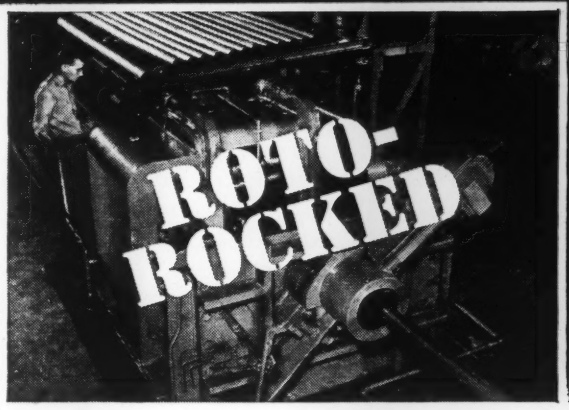
It must be remembered that the load in a joint must be supported by the bolt. If it is necessary to use high-strength bolts, the joint material under the bolt head should be checked. This is true of rigid as well as gasket joints.

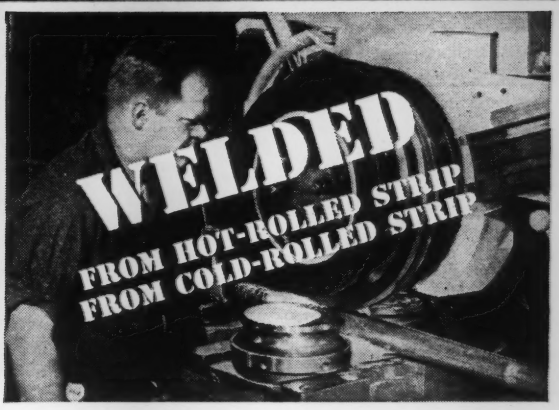
Bolt Threads: There is one more important element in the strength of a bolted joint—the thread. Certainly, one series of threads would simplify problems from the design end and would save money through simplified stock and lower inventories. A large manufacturing company making a wide range of products has adopted the coarse thread series and has experienced very satisfactory results. If it is agreed that the single thread series is a good idea, usage is practically limited to

Let's take a

CLOSER LOOK

at TYPES of Tubing





Different in surface finish. Different in dimensional tolerances. Different in machinability. Different in cost. Once you have determined to simplify fabrication of hollow parts with versatile seamless or welded tubing, be sure you're using the *right type* for the job at hand. If you're a long-time tubing user, review all types available to *know* that you're getting the most for your money. Each type has its place—ONE type is best for *your* specific requirement.

The B&W Technical Staff is always ready to cooperate with you in the selection of the proper carbon, alloy, or stainless tubing for your job. Their aim is to help you avoid difficult fabricating problems, eliminate rejects, and save production time and costs.

If you have a specific tubing requirement, tell us end-use, OD, ID, size of finished part, method of chucking and sequence of machining operations, description of finished part, finishing procedure—welding, brazing, plating, heat-treating, carburizing, nitriding, special dimensional accuracy if required, and type of finish desired. Put your problem up to Mr. Tubes—your B&W Tube Representative.

New Bulletin TB-340 is a compact guide to mechanical tubing possibilities, and well worth writing for.

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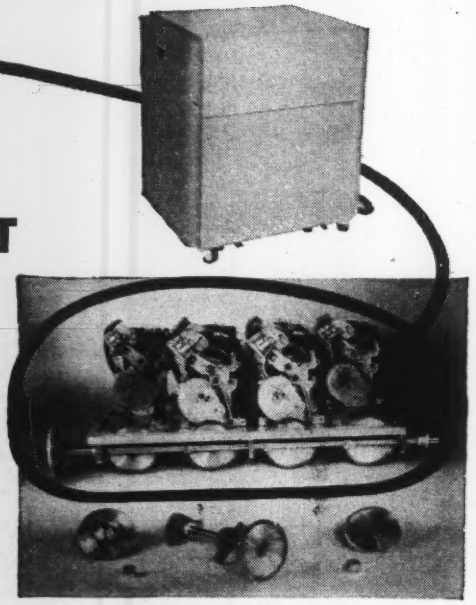

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coarse threads, because there are very few instances where fine threads can be tapped in castings.

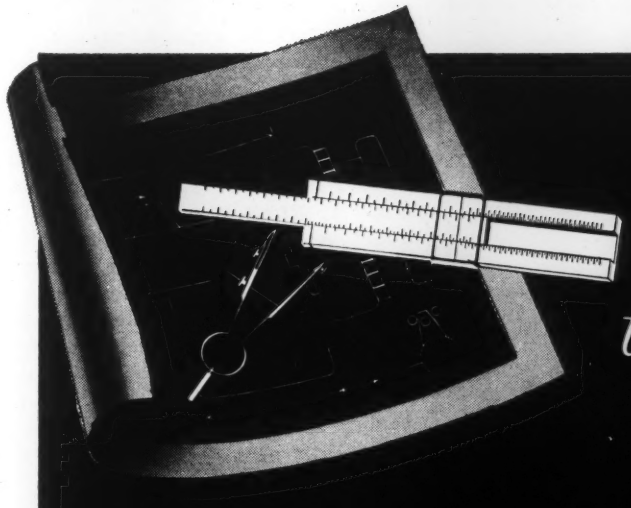
There are some sound engineering reasons why the coarse thread is more advantageous than the fine. It has been proved that the stress distribution in the nut having coarse threads varies from 53 per cent of the average at the top of the nut to 179 per cent at the base, while with fine threads the loads vary from 37 per cent of the average at the top of the nut, to 231 per cent at the base. Because of this condition, bolts with fine threads, when used in steel nuts and loaded statically, have failed at stresses far under the tensile loads of the bolting material. However, this was not true of coarse threads.

Loosening of bolts and nuts in service is sometimes a problem and it has been claimed that fine thread products are less apt to loosen. However, it would appear that neither coarse nor fine thread fasteners will loosen if bolted joints are designed to avoid excessive load changes in the bolt. This has been demonstrated by recent research in the use of high-strength bolts in structures such as railway bridges, ore unloaders, and similar structures subject to severe shock and vibration.

Stress Areas Vary

One of the most frequently cited advantages of fine threads is a higher computed static tensile strength based on the larger tensile stress area. Actually, this stress area is about 12 per cent larger for fine thread bolts. The difference usually can be absorbed in the safety factor, except possibly in critical applications such as aircraft. In any case, the higher breaking load of fine thread bolts cannot be utilized unless the stripping strength of the threaded connection is at least as high, which is sometimes not the case. Following are some of the factors affecting stripping strength:

1. Load concentration on the first thread inside the nut is proportionately greater in fine threads, thus precipitating progressive failure of succeeding threads at lower than expected loads. This occurs to a greater degree when either the internal or the



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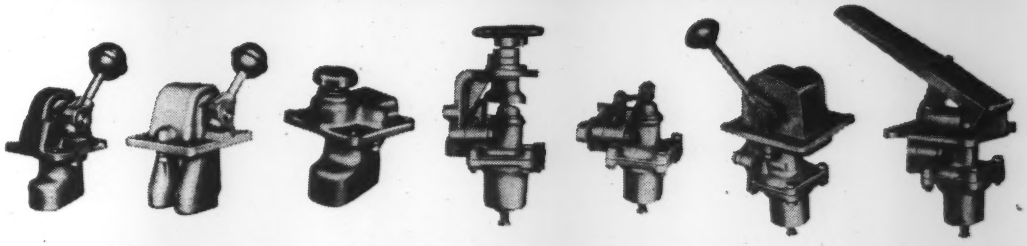

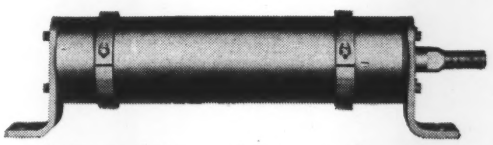

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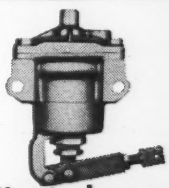

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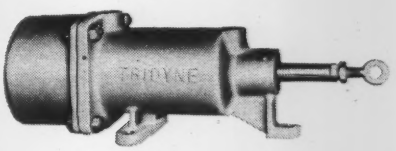

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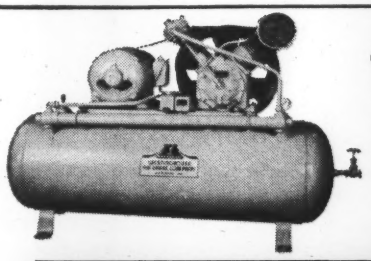

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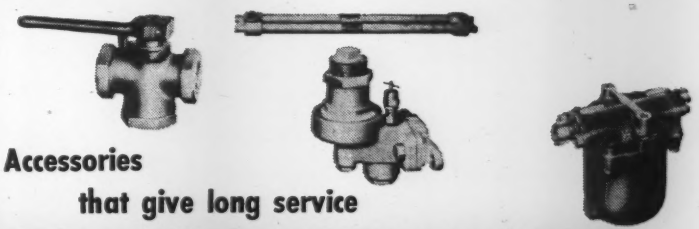

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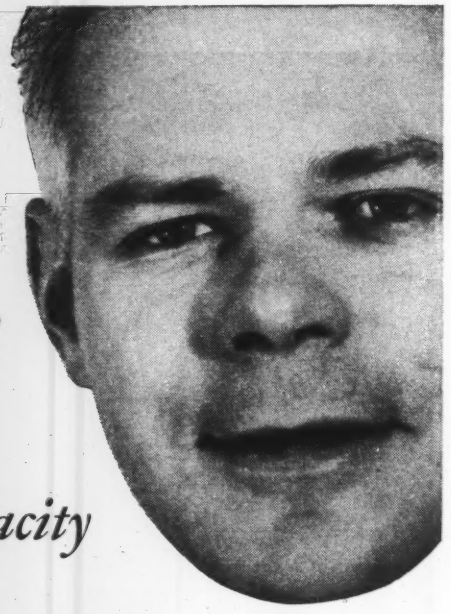

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external thread material is rather hard or brittle, such as in the case of holes tapped in brittle cast iron. However, coarse threads are generally used in these cases.

2. Decarburization often is present at and below the surface of threads and is difficult and expensive to avoid. A given amount of decarburization is less effective in reducing the stripping strength of coarse threads because of their greater thread depth. Coarse threads are necessary to sustain stripping strength when studs or bolts are used in holes tapped in soft material such as copper alloys and aluminum, or when both bolt and nut are made of these materials.

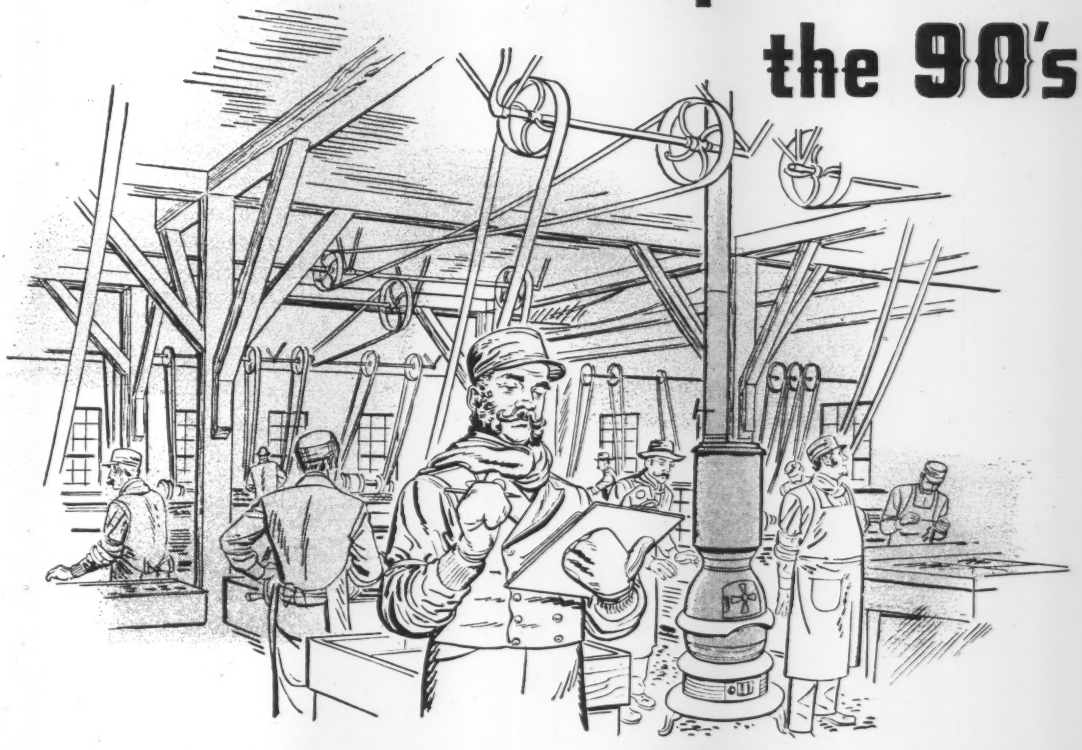
3. When a nut is loaded, it tends to expand because of the wedging action of the thread. This expansion occurs most markedly at the nut base because of the load concentration at the first thread inside the nut. This expansion results in movement of the nut threads radially with respect to the bolt threads, producing thread contact at thinner sections of the thread and thus precipitating stripping. This expansion has less effect in reducing stripping strength of coarse threads because of their greater thread depth.

4. Corrosion is less damaging to coarse threads because of their comparatively larger size. This is important to equipment, machinery and structures subject to constant outdoor exposure. Protective coatings may be employed, in which case they are more effective when applied to coarse threads. Hot galvanizing is difficult and is generally only practical for bolts of 16 threads per inch and coarser. This is also true of other heavier coatings, such as copper-nickel-chrome plating, which are generally specified with coarse threads. Where threads are too fine it is often necessary to go to the expense of special or additional operations to effect proper assembly with heavy coatings.

5. Coarse threads are less difficult to handle since they are less sensitive to damage from slight nicks, particularly in the larger sizes.

6. Coarse thread products are less difficult to assemble. The fact that a coarse thread fastener requires only two-thirds the revolutions of a fine thread in assembly leads to lower cost. A coarse thread bolt enters a nut or tapped hole with less tendency to cross-thread, even when mating parts are not truly positioned with respect to each other. Nuts which are located in inaccessible

Efficiency Dropped with the Temperature in the 90's



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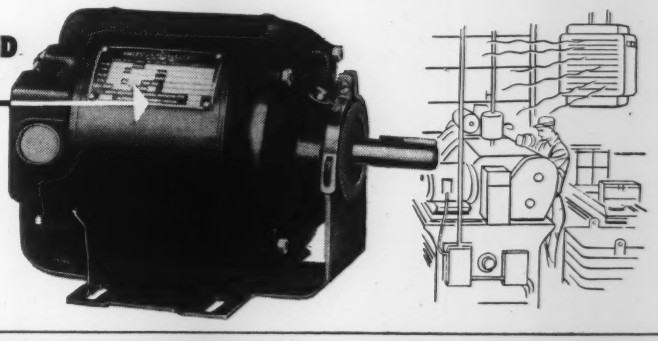

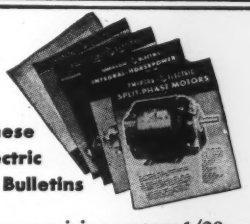

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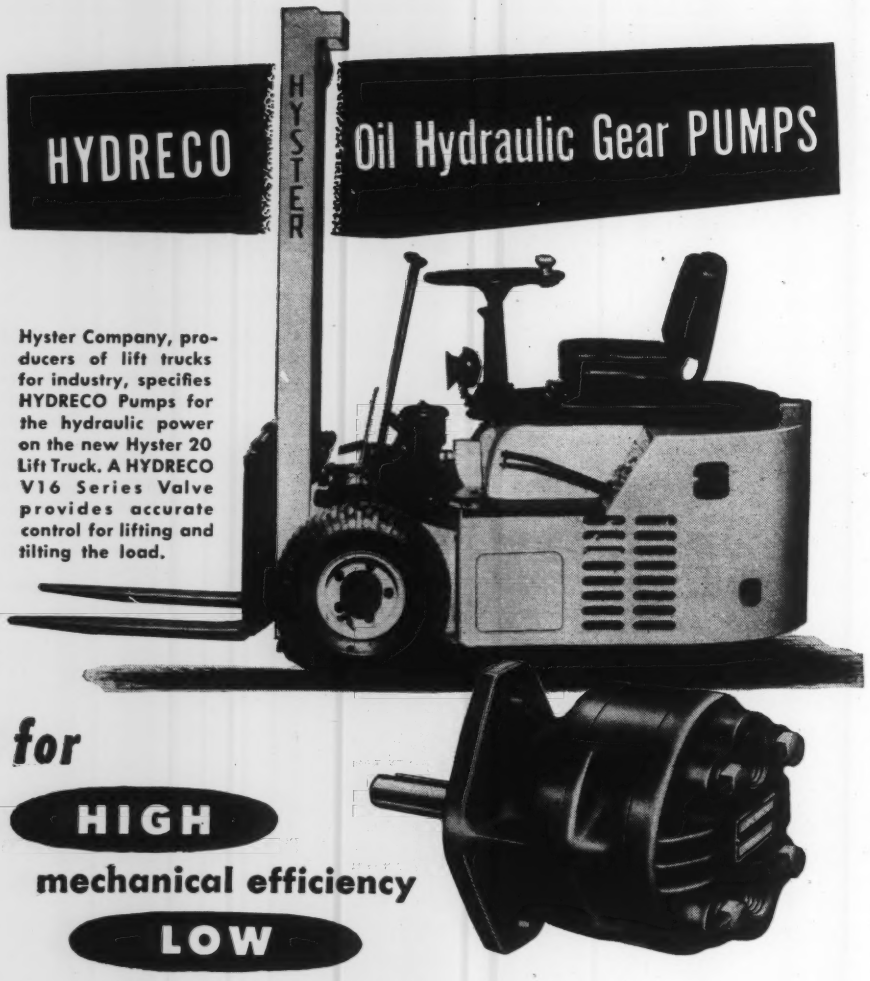

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places are usually coarse threaded. Coarse thread fasteners are less apt to gall and seize in high-cycle assembly. These difficulties in assembly may be minimized in original shop assembly, but in the field, troubles increase, particularly where repairs and reassemblies must be made several times during the life of a piece of equipment.

Bolted joints are strong. They can be the strongest joints made. They are the muscles of machines —design them well, select proper fasteners, and make sure they are preloaded.

From a paper of the same title, presented at the Twentieth Annual Meeting of the ASTE in Chicago, Ill., March, 1952.

Magnesium-Rare Earth Alloys

By J. C. McDonald
The Dow Chemical Co.
Midland, Mich.

MAGNESIUM-RARE earth metal alloys have particular merit in castings for service at elevated temperatures. Although the magnesium - aluminum - zinc type casting alloys, which have been made for many years, can also be used efficiently at considerably elevated temperatures, depending on the magnitude of the stresses imposed, somewhere between 200 and 400 F it usually works out that a lighter design can be accomplished if a magnesium-rare earth metal alloy can be used. This will be true particularly when the operative stresses are high enough to require wall thicknesses greater than the desired maximum.

Magnesium-rare earth metal alloys were investigated many years ago in Germany, but only in the last few years have cast alloys become commercially available. Zirconium, which is employed as a second essential alloying element in all of these alloys, refines the grain of the casting, prevents cracking during freezing, and improves the casting properties.

The main magnesium-rare earth cast alloys, TABLE 1, now being produced commercially contain approximately 3 per cent "mischmetal" (cerium, lanthanum, neodymium, and praseodymium) which costs about $4.50 a pound. At this

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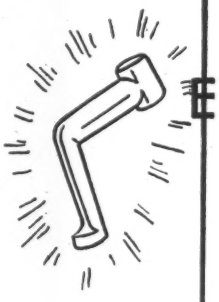

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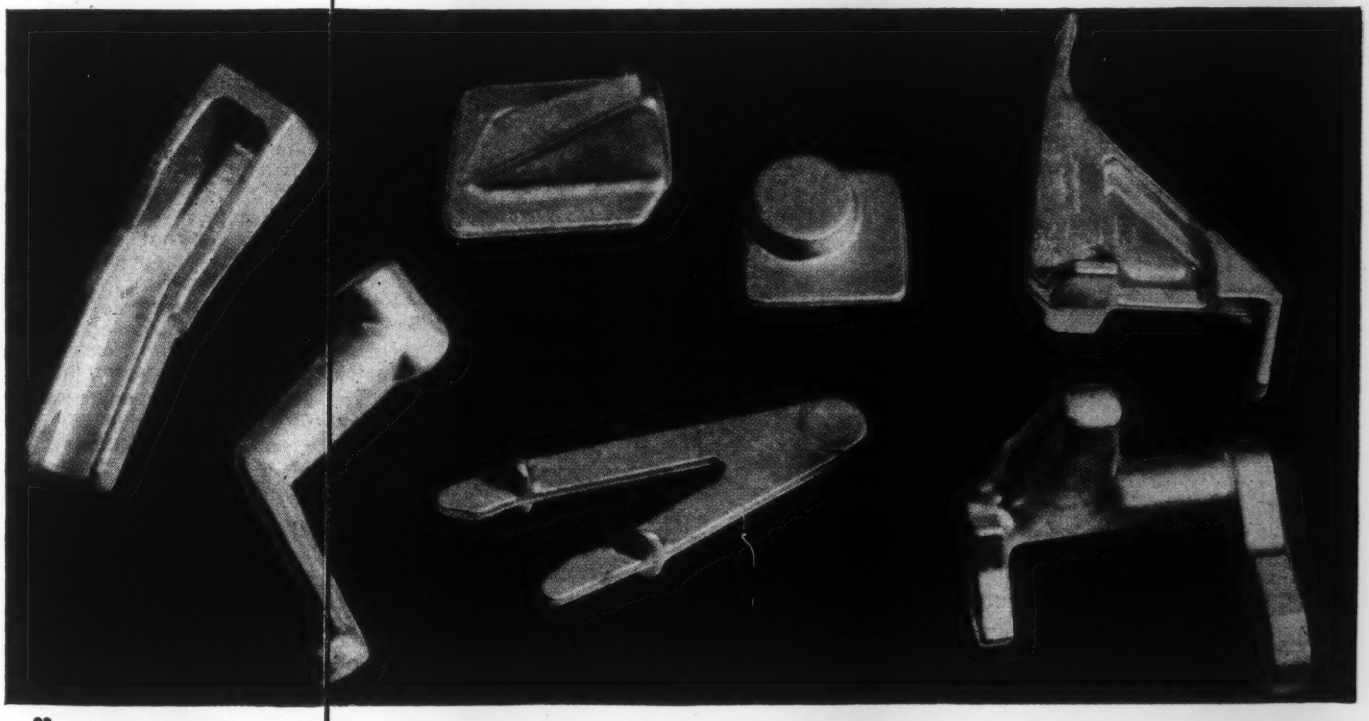

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price it is evident that alloys containing mischmetal are going to cost more than those using aluminum or zinc, everything else being equal.

While the price of zirconium in compounds is not high, its actual cost in the casting is a function of the efficiency of alloying obtained in each foundry. From the foundry standpoint, 0.25 per cent zirconium is adequate for grain refining.

For the rare-earth alloys, there are several alternative ways of achieving creep strengths which are higher at elevated temperature than can be obtained with the mag-

Table 1—Commercial Magnesium-Rare Earth Alloys

Alloying Elements Zr (%)	Mischmetal (%)	Heat Treatment	Tensile* Strength (1000 psi)
0.25	3	Precipitation	20
0.25	3	Solution-Precipitation	23
0.55	3	Precipitation	22
0.55	3	Solution-Precipitation	25

* At 400 F

nesium-aluminum-zinc alloys; a comparable value at 400 F would be 1500 psi for the aluminum-zinc alloys, 8000 psi for the rare earth metal alloys. TABLE 1 illustrates commercial practice in the use of these alternative procedures which are: (1) Varying zirconium content, (2) employing solution heat treatment and precipitation heat treatment, and (3) using precipitation heat treatment only.

Creep strengths of the mischmetal-containing alloys are quite comparable; all should function equally satisfactorily at elevated temperature. There are, however, slight differences in respect to tensile properties, TABLE 1, which might lead designers to prefer one or the other of these compositions.

These alloys behave similarly in the foundry. More difficulties are encountered in respect to control of composition and oxidation, than with the older alloys, but these factors can be controlled. The factor for shrinkage from pattern dimensions is higher for the rare earth alloys than for the magnesium-aluminum-zinc alloys, making it difficult to use existing patterns on large castings. Service experi-

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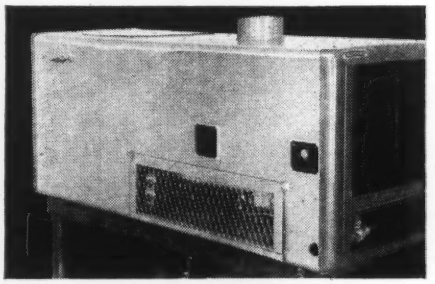

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ence with corrosion has been satisfactory on all these alloys.

Published work in respect to didymium (neodymium and praseodymium) and thorium has indicated certain merits in the use of these materials for magnesium base alloys intended to be used at high temperature. While use of didymium does produce superior tensile properties up to 400 F it is noteworthy that the alloy with thorium not only has equal or superior tensile properties compared to the rare earth metal alloys at all temperatures up to 600 F, but in addition possesses a very much higher creep strength at 600 F. Research and development concerned with bringing the thorium-containing alloys into production is currently in progress.

From a paper entitled "Magnesium Casting Alloys Containing Rare Earth Alloys," presented at the Seventh Annual Meeting of the Magnesium Association in New York, N. Y., November, 1951.

Industry's Amazing Oversight

By Professor Erwin H. Schell

Business Engineering Administration
Massachusetts Institute of Technology
Cambridge, Mass.

NO ONE is at fault. No one is to blame. Indeed, if anyone should have seen it, we educators were the ones. We have not been so enmeshed in the urgent details of industry as have the industrialists. Our noses were farther from the grindstone. But we did not see it.

When we left our trains at their stations and passed down the platforms alongside the moguls or the great diesels with the men in blue denim caps in the cabs, we should have seen it. But we did not.

When we stood on the bridge of the transatlantic liner, watching the man in the wheelhouse, we should have seen it. But we did not.

When we climbed into the air cruiser and saw the glint of the sun on the buttons and braid of the pilots as they went forward into the maze of dials around their perches in the forward quarters, we certainly should have had an inkling of the truth. But it never

seemed to enter our minds.

Certainly, when we looked at the lines of cars speeding daily along the highways; when we watched the neighborhood handyman behind the power lawnmower; when we followed in the mirror the peregrinations of our barber's electric clippers, I really don't see how we could have missed it. But we did.

Change Was Gradual

Perhaps it was because the change had taken place gradually. Sometimes trends are so deliberate that we do not recognize small changes until something focuses our attention upon their accumulation.

Perhaps we started off on the wrong foot in our thinking. As Elihu Thompson used to say, the greatest enemy of thought is the preconception, for when this preliminary assumption is in error, it curses our entire thinking forever after, no matter how high the quality.

For example, back in older days, when bosses cracked bull whips in the fields, and even earlier, when slaves bent to the oars of triremes, human relations were governed by the preconception of a basic difference in people—a difference that really was not there.

Slowly the question took form. Is the machine operator more than a worker? Could it be that machine operators perform a kind of management? True, they do not manage people; but do they not, in reality, manage machines?

Incentives Differ

Of course there is a difference. In machine management, the incentive for increased tempo may come out of an oil-can rather than a payment plan, whereas in managing people a knowledge of human motives and "drives" is essential.

And what about those employees —men and women—whose work does not involve machine operation? Are they without managerial fitness? Or may they, in spite of the absence of factory production equipment, qualify in some measure as managers? With these immediate questions in mind, I be-

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came aware of a trend which is perhaps the most extraordinary of our time—the growth of machine management outside the factory walls.

Today there is scarcely a household in this country in which machine management is not practiced in one form or another. The automobile, the refrigerator, the washing machine, and the vacuum cleaner are only a few examples of the vast congeries of home equipment, the competent operation of which has called heavily upon the bedrock principles of good management.

How profoundly Karl Marx erred in picturing man as the slave of the machine! Today man as never before—in his work, his home, his play—is the acknowledged master of the mechanisms he employs. Machines have made men free.

Management is Inherent

As the picture came more sharply into focus, I realized that management is not, at base, a matter of occupation—of machines, of jobs, of work. I realized that it marks a stage of life; that there comes a time in every human being's existence—frequently upon leaving the parental home—when he or she is no longer managed. That is when self-management begins. Moreover, management is an attitude of mind which has vigorously rebelled against enclosure in any given social or industrial stratum.

Suddenly it became evident that management is a particular form of social activity, a kind of doing that is in no way the perquisite of any single class; that it is no longer bound by traditional channels; that it is an inherent ingredient, in large or small degree, in the lives of every one of us.

What has been happening in and out of our factories and mills? Unnoticed, a great body of, shall we say, equipment managers has been accumulating throughout our industries and our communities. Without herald or fanfare, the increasing transfer of skill and effort to the machine, whether in the workplace, in the home, or on the highway, has in turn developed new qualities of managerial proficiency in those who put these en-

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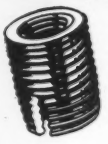


• • • for strong tapped threads in soft materials

STRIPPING of tapped threads in soft materials is easily prevented by the Tap-Lok Insert—a hard steel bushing. Being self-tapping and simple to install, it is widely used in original installation in soft metals, plastics and other materials. It is also extensively used for salvage of rejects and for maintenance. Adoption of the Tap-Lok Insert can have an important effect on the cost and the sale of your products.

INSTALLATION

1. Simple driving tool with threaded stud engages interior thread of insert.

2. Driver turns self-tapping insert into cored or drilled hole equal in size to tap drill hole for external thread of insert.

3. After insert is seated, male threaded member is driven into interior thread of insert.

U. S. Patent 2,455,885

*Reg. U. S. Pat. Off.

Send for samples and descriptive folder.

Also manufacturers of Groov-Pins for positive locking press fit.

GROOV-PIN TRADE MARK REG. U.S. PAT. OFF.

GROOV-PIN CORPORATION

1129 Hendricks Causeway, Ridgefield, New Jersey

cial institution will focus attention sharply upon the task of improving the self-reliance, self-confidence and self-initiative of its worker personnel, in order to bring these abilities to a point at least equal to that now provided by other major vocations—for example, agriculture. This can result only when employees are given wider opportunity for self-development in the business of machine management, job-management, and self-management.

We anticipate that the power of financial incentives will steadily wane. Obviously, new forms of human satisfaction must be provided if we are to maintain the advantages of private enterprise. Foremost among these is the satisfaction which comes with truly belonging to the group—of becoming dedicated to a common cause.

New Incentives Needed

The wish to participate in the direction, guidance and control—in short, in the management—of affairs is one of the deepest desires of man. The machine and the technical process in factory and home have provided effective vehicles for the satisfaction of this basic urge and for the development of skills in managerial techniques.

May industry set about building a new and mighty unit on the basic principle that all men of industry, whether officials or operators, from president to lowliest employee, are in varying degree executives in their own right.

May industry recognize and act upon the opportunity to close its ranks over and across that obsolete remnant of earlier days and earlier ways—that artificial abyss of class distinction which has heretofore separated management and labor.

Why should it have taken us so long to see these changes, developing over the years before our very eyes? How can we explain our amazing oversight?

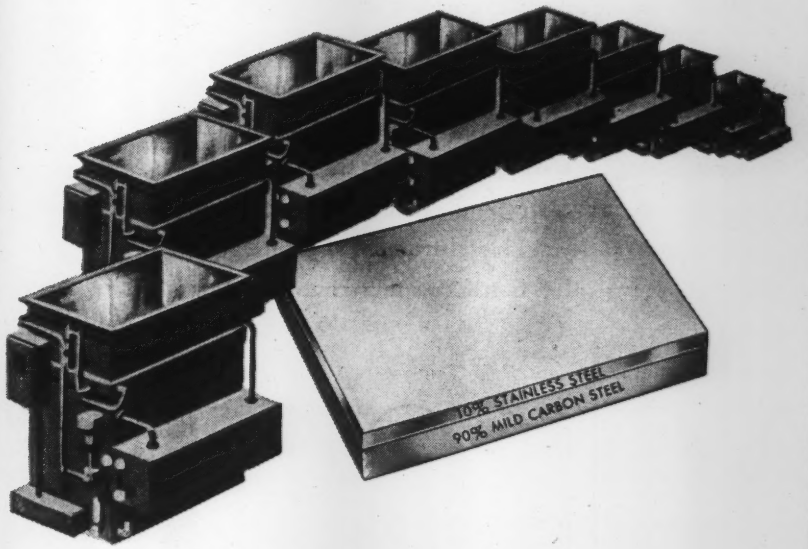
I think of the old saying of the Pennsylvania Dutch:

"Ve grow so soon old—
Und so late schmardt!"

From an address of the same title delivered before the Spring Manufacturing Conference of the AMA in New York, April, 1952.

How to Make Stainless Protection Go NINE TIMES FURTHER... with PERMACLAD

STAINLESS CLAD STEEL



Want stainless protection for your product or equipment—without wasting stainless steel? You'll get it at low cost—with PERMACLAD!

A 10% layer of stainless, inseparably welded to a 90% mild steel backing, gives PERMACLAD the surface characteristics of solid stainless *and* the easy forming qualities of carbon steel. This means real savings in corrosion resistance and in fabrication as well. For you can cold-form PERMACLAD with ease, draw it deeper without intermediate annealing, actually form it into products impossible with many other materials.

Even with the most severe draw, the percentage of cladding (which can be 20% or more if desired) never varies. And the stainless layer remains inseparably welded to its backing. For gleaming, stainless products and corrosion resistant equipment, design and build with PERMACLAD. The coupon below brings you full details in our new 8-page folder (P-98).

Send for Free Folder Today

FOR BETTER PRODUCTS AT LOW COST . . . SPECIFY PERMACLAD

ALAN WOOD STEEL CO. ESTABLISHED 1826 A.W. CONSHOHOCKEN, PA.

PERMACLAD

STAINLESS CLAD STEEL

STEEL SCRAP FIGHTS FOR DEFENSE. SELL YOUR SCRAP NOW!

ALAN WOOD STEEL COMPANY Conshohocken, Pa.

Over 125 Years of Iron and Steel Making Experience

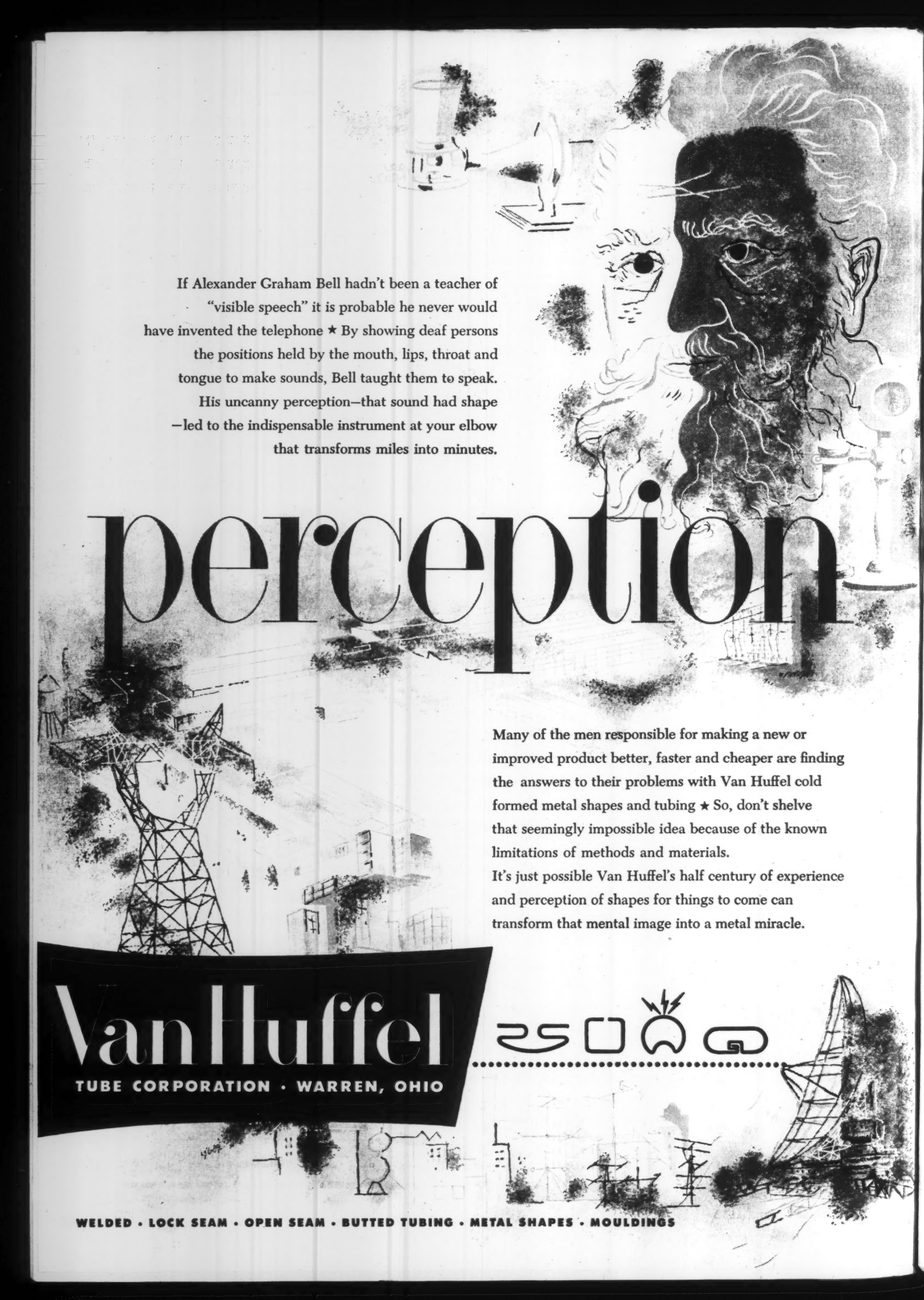
Gentlemen:
I am interested in stainless protection with PERMACLAD.
Please send me full information and new, free folder (P-98).

Name _____ *Title* _____

Company _____

Address _____ *City* _____ *State* _____

Other Products: A.W. ALGRIP ABRASIVE Floor Plate • A.W. SUPER-DIAMOND Floor Plate • Plates • Sheets • Strip • (Alloy and Special Grades)



If Alexander Graham Bell hadn't been a teacher of "visible speech" it is probable he never would have invented the telephone ★ By showing deaf persons the positions held by the mouth, lips, throat and tongue to make sounds, Bell taught them to speak. His uncanny perception—that sound had shape—led to the indispensable instrument at your elbow that transforms miles into minutes.

perception

Many of the men responsible for making a new or improved product better, faster and cheaper are finding the answers to their problems with Van Huffel cold formed metal shapes and tubing ★ So, don't shelve that seemingly impossible idea because of the known limitations of methods and materials.

It's just possible Van Huffel's half century of experience and perception of shapes for things to come can transform that mental image into a metal miracle.

Van Huffel

TUBE CORPORATION · WARREN, OHIO

WELDED · LOCK SEAM · OPEN SEAM · BUTTED TUBING · METAL SHAPES · MOULDINGS

GAST rotary AIR MOTOR drives agitator for BONDACTOR CEMENT GUN

PROBLEM: Design to feed dry sand-cement aggregate uniformly from mixing hopper to airline of Bondactor Cement Gun.

SOLUTION: Agitate dry mixture with Gast 4 AM rotary Air Motor driven by compressor which supplies gun.

RESULT: Economy, dependability and needed flexibility in feeding from ½ to 2 cu. yds. of concrete per hour. Unit withstands rough treatment, outdoor use by contractors.

Yes — this is another of scores of design problems *solved* with Gast rotary Air Motors. If rotary air power is a possibility on *your* product, let Gast engineers review your problem. You may profit from their concentrated experience with air power, low vacuum or pressure. Remember, "Air may be your answer!" Write for details.

SEE OUR CATALOG IN SWEET'S FILE — Gast Application Ideas booklet — showing 26 design problems solved — sent upon request.

Original Equipment Manufacturers for Over 25 years

GAST ROTARY

AIR MOTORS · COMPRESSORS · VACUUM PUMPS

(TO THREE H.P.) (TO 30 LBS.) (TO 28 INCHES)

GAST MANUFACTURING CORP., 807 Hinkley St., Benton Harbor, Mich.

News

OF MANUFACTURERS

CONSTRUCTION of a 90,000 sq ft plant in Detroit for manufacturing permanent magnets has been announced by Carboloy Department of **General Electric Co.** The new plant will house complete manufacturing facilities and will provide room for future expansion and new processing operations. It is expected that construction will be completed in the spring of 1953. The plant will be located adjacent to the Carboloy Department's new carbide-tool fabricating plant recently completed and now in full-scale operation.

♦

Development and testing of combustion and process control systems and instruments will be a major function of the new research and development laboratory nearing completion at the Orville, O., plant of **Hagan Corp.,** Pittsburgh. Apparatus for frequency-response testing of all types of components of control systems and instruments will be perfected in the new laboratory.

♦

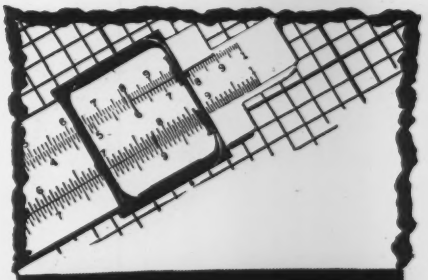
Texas Engineering and Manufacturing Co. Inc., Dallas, Tex., has shortened its name to **Temco Aircraft Corp.**

♦

A new plant for sensitizing and converting paper, film and cloth has been put into operation by the **Charles Bruning Co. Inc.,** Teterboro, N. J. The new building houses the national management offices, formerly located in New York, as well as the research laboratories and manufacturing operations formerly located in different sites around metropolitan New York.

♦

A new five-year program of financial aid to science students in eleven leading universities has been announced by **United States Rubber Co.,** New York. The universities which have accepted the fellowships are California Institute of Technology, Cornell University,



FOR BETTER SPEED CONTROL USE *Servospeed*

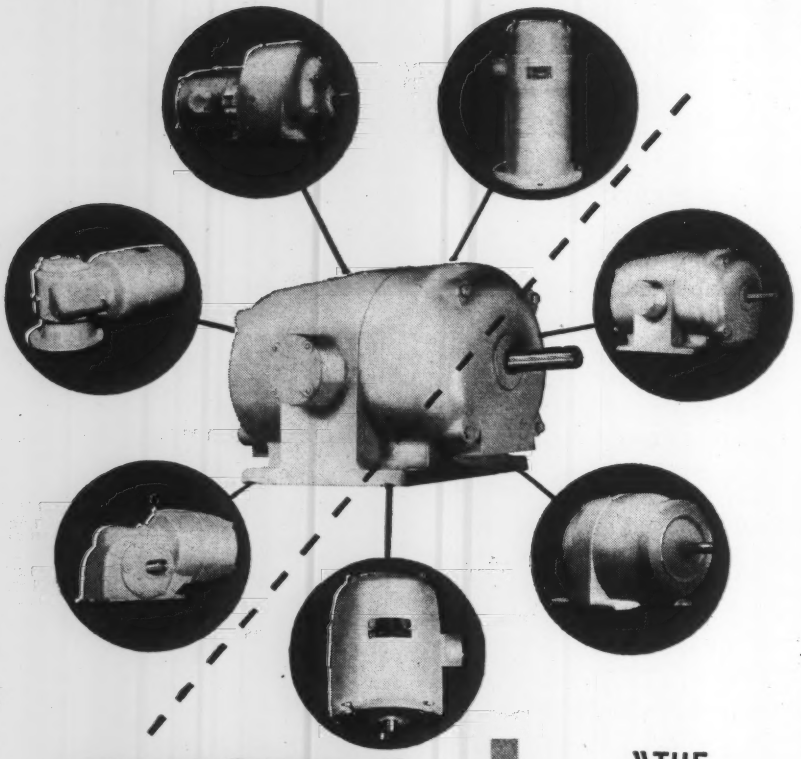
MODERN ELECTRONIC ENGINEERING GIVES PRECISE

FINGERTIP SPEED CONTROL

- TACHOMETER PROPORTIONING
- TENSION OR POSITION CONTROL
- MOTOR INTEGRATORS
- BI-DIRECTIONAL
- DYNAMIC BRAKING
- SERVO CONTROL

Servo-Tek products co

4 Godwin Ave. Paterson, N. J.



ELECTRA "THE LIGHTWEIGHT CHAMPIONS"

FULL POWER IN HALF THE WEIGHT

ELECTRA, a newcomer only 5 years ago, has successfully defended its title against tough competition. Its steady growth—a matter of record — is proof that ELECTRA wins the buyer's decision wherever genuine quality, dependable performance and long life combined with light weight are required. That's why ELECTRA-MOTORS and ELECTRA-GEARMOTORS have frames of heat-treated alloy aluminum—stronger and better than ordinary castings—lighter than iron and steel.

DESIGN — The men who build ELECTRA-MOTORS have had years of experience in motor production plus a demonstrated ability to design units to meet special requirements and unusual applications. As a result, ELECTRA offers many exclusive advantages in 7 basic types of motors and gearmotors, from ¼ HP through 5 HP, speeds from 1 rpm up. Special problems get special attention...promptly.

DISTINCTIVE in appearance, ELECTRA-MOTORS streamlined design is abreast of modern trends. Their heat-treated alloy aluminum frames can be polished, if desired.

WRITE FOR ENGINEERING DATA on ELECTRA-MOTORS and ELECTRA-GEARMOTORS, or tell us your requirements and we'll submit our recommendations.

REPRESENTATIVES IN PRINCIPAL CITIES
NATION-WIDE DISTRIBUTION AND SERVICE

Electra ELECTRA MOTORS, INC.
ANAHEIM, CALIFORNIA

Harvard University, University of Illinois, Massachusetts Institute of Technology, Northwestern University, University of California, University of California at Los Angeles, University of Chicago, University of Minnesota, and University of Wisconsin.

♦

Pittsburgh Plate Glass Co., Pittsburgh, recently opened a new plant in Baltimore for the manufacture of industrial brushes to provide additional research, development and production facilities for expanding power-driven brush operations. The company previously utilized space in its adjoining paint and varnish brush factory for producing industrial brushes.

♦

Pamco Corp., is the new name recently adopted by Panhandle Machine Co. Inc. of Lubbock, Tex.

♦

Racine Tool & Machine Co. has moved into a newly modernized plant comprising an approximate 50 per cent increase in manufacturing floor space, and has changed its name to **Racine Hydraulics & Machinery Inc.** The company's new address is 2000 Albert St., Racine, Wis.

♦

Colonial Aluminum Smelting Corp., Columbia, Pa., has put into operation its new secondary aluminum smelter for the production of secondary aluminum ingots.

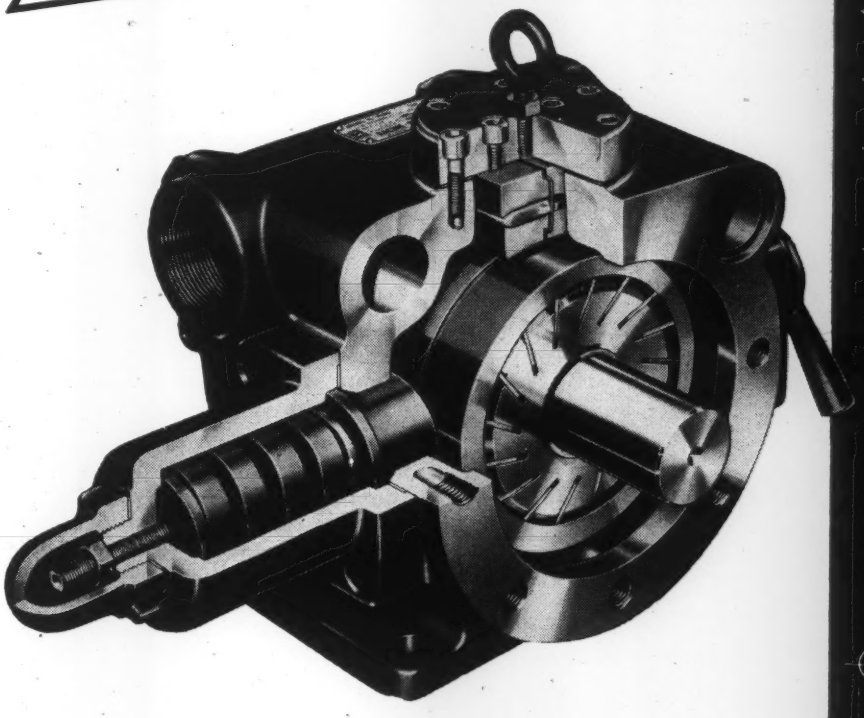
♦

The Yale & Towne Mfg. Co. has established a research and development division to co-ordinate and supplement research and product development activities now being conducted at the company's eight manufacturing divisions in the United States, Canada, England and Germany.

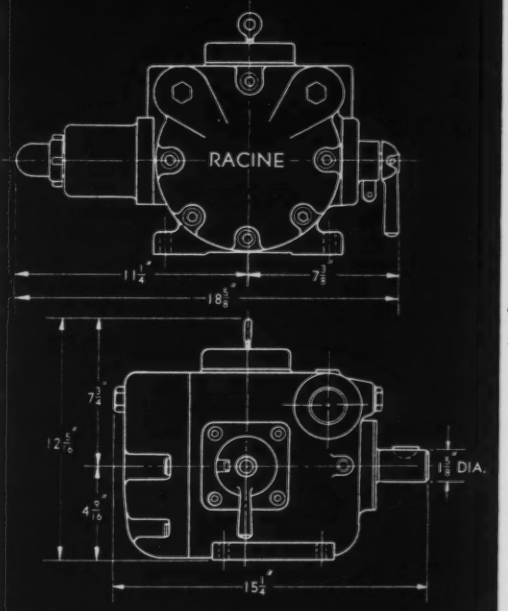
♦

Completion of additional facilities at Harbor Island and at Kure Beach, near Wilmington, N. C., has been announced by **The International Nickel Co.,** New York. At Harbor Island, the addition consists of a new two-story building which, with the original laboratory building built about a year and a half ago, provides 8000 sq ft of space. One of the most im-

New RACINE 70 gpm VARIABLE VOLUME PUMP



- ★ 70 GPM AT 1200 RPM
- ★ VARIABLE VOLUME
- ★ PRESSURE COMPENSATED GOVERNOR
- ★ LEVER VOLUME CONTROL
- ★ FOOT MOUNTED
- ★ MAX. WORKING PRESSURE—1000 PSI



This new Model K 70 gpm Variable Volume Oil Hydraulic Pump is an important addition to Racine's broad line of hydraulic products. It is equipped with a pressure compensating governor which automatically regulates the maximum pressure to the hydraulic system and provides safe and adequate over-pressure protection.

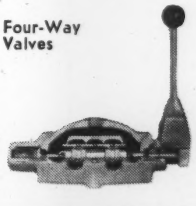
An additional manual lever control regulates the volumetric onput of the pump to meet circuit requirements.

Write for complete descriptive catalog on Model K 70 gpm Oil Hydraulic Pump

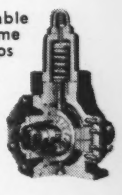
BUY DEFENSE BONDS

OTHER RACINE HYDRAULICS PRODUCTS

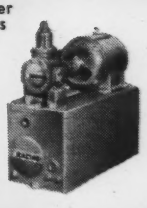
Four-Way Valves



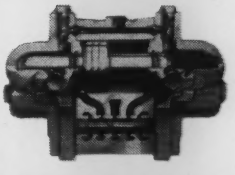
Variable Volume Pumps



Power Units



Pressure Boosters



RACINE

RACINE HYDRAULICS &

2073 ALBERT STREET, RACINE, W

HERE "under one roof" at FAIRFIELD is *everything* needed for producing fine gears — metallurgical department, batteries of the most modern machines, testing laboratories, complete heat-treating facilities — all operated by skilled craftsmen working under expert engineering supervision. By specializing exclusively in "FINE GEARS MADE TO ORDER" for more than thirty years, FAIRFIELD has become one of America's largest producers of these parts. This is why many makers of construction machinery . . . agricultural implements . . . machine tools . . . military equipment . . . tractors, trucks, and buses now regularly depend on FAIRFIELD to meet their requirements. *For the Best in Gears, Specify Fairfield!* FAIRFIELD MANUFACTURING CO., 311 So. Earl Ave., Lafayette, Indiana.

FAIRFIELD

portant additions is a full-sized salt water evaporator and distillation unit to study the effects of water treatment and design on corrosion and scaling of such units. The complete unit primarily serves the U. S. Naval Experiment Station in conducting tests for the Bureau of Ships and other branches of the Navy. Facilities for studies of the effects of sea spray and air on test specimens at Kure Beach have likewise been extended. This new sea spray test lot is located about 80 ft from the ocean and has approximately three times the capacity of the old sea spray lot.

♦

Iron Fireman Mfg. Co., Cleveland, has purchased the oil burner business of Petroleum Heat and Power Co., Stamford, Conn., and will operate this business as a division. The entire line of Petro domestic, commercial and industrial oil burners and oil heating equipment will be manufactured in the Iron Fireman Cleveland plant.

♦

Engineering Research Associates Inc., St. Paul, has received Air Force contracts for the production of directional gyro indicators and has leased 11,000 sq ft of additional factory space in St. Paul to accommodate the gyro production program. It is expected that the first units will be delivered in the last half of this year.

♦

The manufacturing division of the **Cro-Plate Co.,** Hartford, Conn., has been expanded to include the entire area of approximately 10,000 sq ft at the company's Windsor St. plant. The contract plating division of the organization, which formerly shared factory space with the manufacturing division, has been transferred to the company's East Hartford plant.

♦

The F. W. Stewart Mfg. Corp. of Chicago has announced the opening of a new plant at 1638 South Flower St., Los Angeles, Calif., which provides additional manufacturing space. This new location will be devoted entirely to the manufacture and fabrication of flexible shaft assemblies, flexible shafting and their components.

Association

ACTIVITIES

AT THE 1952 semiannual meeting of the **American Society of Mechanical Engineers** to be held in Cincinnati, Ohio, June 15-19, the Machine Design division will sponsor three technical sessions—two on Monday, June 16 and one on Tuesday, June 17. Papers will be presented as follows:

Monday 9:30 a.m.

"High Speed Surface Broaching Machine," by E. J. Rivoria and E. Raehrs, Cincinnati Milling Machine Co.

"Machine Tool Lubrication," by James R. Keen, American Steel Foundries Corp.

"On the Solution of the Reynolds Equation for Slider-Bearing Lubrication—II," by A. Charnes and E. Saibel, Carnegie Institute of Technology.

Monday, 2:30 p.m.

"Pressure Angles in Cam Roller Followers," by George Y. Ono, Case Institute of Technology.

"Nomograms as Tools to Facilitate the Solution of Engineering Formulas," by Edward C. Varnum, Barber-Colman Co.

Tuesday, 9:30 a.m.

"The Effects of Solid Inclusions in the Oil Supply to Sleeve Bearings," by H. G. Rylander, Jr., University of Texas.

"The Use of the Centrifugal Governor Mechanism as a Torsional Vibration Absorber," by O. A. Pringle, University of Missouri.

♦

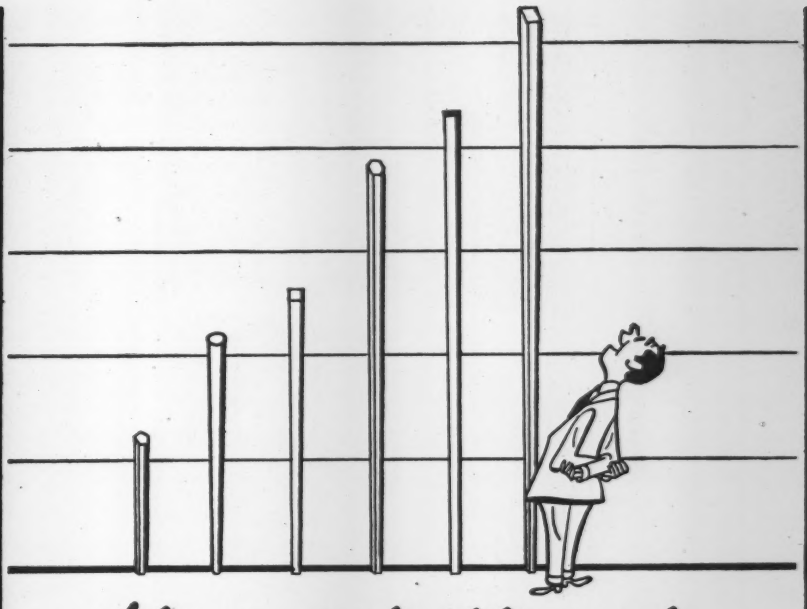
O. A. Wheelon, Douglas Aircraft Co., was awarded the *Wright Brothers Medal* by the **Society of Automotive Engineers** at the Society's Spring Aeronautical Meeting held in New York. Mr. Wheelon received the award for his paper, "Design and Manufacturing Techniques with Titanium," which analyzed the problems of using titanium in airplane design and construction.

♦

A summer employment service for engineering students has been inaugurated by the **American Society for Metals.** The service is furnished without cost to either employers or students. A total of

OVER ONE HUNDRED YEARS OF CONTINUOUS SERVICE. ROUNDS, SQUARES, FLATS, HEXAGONS, OCTAGONS

BILLETS AND FORGINGS FOR PRODUCTION, TOOL ROOM AND MAINTENANCE REQUIREMENTS



things are looking up!

Yes, steel supplies *are* improving tonnage-wise! Even alloy steels are in better supply. However, the continued scarcity of many alloying materials makes certain grades of alloy steel still unobtainable, and substitute grades must be used.

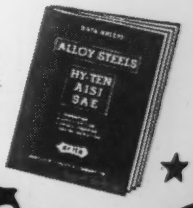
Chances are, we can supply your needs . . . but if we can't, perhaps we can suggest and supply the substitutes best suited for your particular requirements.

Or possibly we can suggest alternative methods of manufacture, or variations in your present methods of treatment.

Your nearest **W-L** office will be delighted to be of service. Call them today!

Get in the SCRAP! . . . every pound means more steel for you!

Write today for your FREE COPY of the Wheelock, Lovejoy Data Book, indicating your title and company identification. It contains complete technical information on grades, applications, physical properties, tests, heat treating, etc.



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ENGINEERS NOTEBOOK

(PHOTO COURTESY NORTH AMERICAN AVIATION)

HEAT AND VENT SYSTEMS

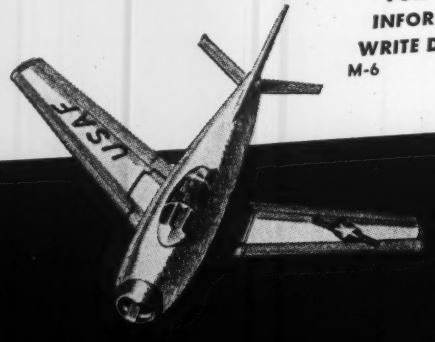
QUICK COUPLING

handles pressure and temperature in de-icer system

Marman V-Band Couplings with patented Quick Coupler latches connect the shut-off valve, pressure limiting valve, and air supply line from engine compressor to anti-icing line in the F-86. In this application they are called upon to withstand pressures of 125 p.s.i. and temperatures of 600°F. This is one of thousands of applications where these standard couplings furnish a light weight, positive seal for tubing and ducting under difficult conditions of temperature, pressure, vibration and stress. The Quick Coupler latch insures maximum speed in assembly and disassembly. Marman's ten years of specialization in the design and production of clamps, straps and couplings of all kinds assure consistent and dependable quality.

FOR INFORMATION, WRITE DEPT. M-6

3-422 17



MARMAN PRODUCTS CO., Inc.
11214 EXPOSITION BLVD.
WEST LOS ANGELES 64, CALIF.

SAVE TIME, WEIGHT, MONEY WITH MARMAN

1856 openings have been specified with firms from coast to coast. These job opportunities are varied —production, metallurgy, laboratory, machine shop, heat treating, finishing, testing, welding, foundry, and others. The purposes of this program are both to assist industry in obtaining skilled workers in all engineering departments and to aid the student in applying his knowledge and training to the job. Distribution of the ASM summer employment opportunities list is being made to the heads of all engineering schools and to many other engineering groups.

♦

A world-wide system of standards for ball and roller bearings will be discussed by international standardization experts meeting in New York, June 16 to 26. The meetings will be held at Columbia University in conjunction with the second triennial General Assembly of the 33-nation International Organization for Standardization. The **American Standards Association** will act as host at the two weeks of ISO meetings. The ISO project seeks to standardize terminology and definitions of bearings and bearing parts; nominal dimensions and tolerances of ball and roller bearings affecting their assembly with other machine parts; methods of inspection; methods of evaluating load ratings; and dimensions of mounting accessories.

♦

The **Resistance Welder Manufacturers Association** has announced the deadline for their Prize Paper Contest as July 31, 1952. For those in industry or laboratory research a first prize of $750, a second prize of $500, and a third prize of $250 will be awarded. Papers emanating from a university source, the author of which is either an instructor, graduate student, or research fellow, are eligible for a $300 first prize and a $200 second prize in this classification. Undergraduate students may submit papers for a $250 award. Complete details regarding the subject matter of the papers and other contest rules may be obtained by writing to the Resistance Welder Manufacturers Association, 1900 Arch St., Philadelphia 3, Pa.

Case History M-114

Here's what we mean by SUPERIOR ENGINEERED FOUNDRY PRODUCTS...

PROBLEM:

1. As originally designed, this clevis lacked eye-appeal, detracting from the appearance of the finished product of which it was a component part.
2. The fact that twelve pieces were required for each complete unit caused excessive handling, machining and assembling, made the part expensive to produce.
3. Because of its design and shape, the unit frequently failed to function properly.
4. Weight of unit, 3 lbs. 11 ozs.

SOLUTION:

A SUPERIOR FOUNDRY ENGINEERED DESIGN one-piece malleable iron casting.

RESULT: 45.9% SAVINGS

1. Smooth, flowing lines of re-designed clevis improved appearance of customer's finished product.
2. Redesigned clevis resulted in lower production cost per unit — only five pieces per unit required. Holes for pulley axle were cored.
3. Smooth shape of clevis permitted part to function properly at all times, improved performance of finished product.
4. A weight reduction of 1 lb. 7 oz. for complete unit.

TOTAL COST OF PART REDUCED 45.9%

You, too, can get advantages like these! Consult our PRODUCT DEVELOPMENT SECTION regarding your problem while it's still on the drawing board. Remember... correct design benefits both you and the foundry, regardless of size of casting.

ENGINEERED FOUNDRY PRODUCTS

Since 1916

SUPERIOR STEEL AND MALLEABLE CASTINGS CO.

BENTON HARBOR, MICHIGAN, U.S.A.

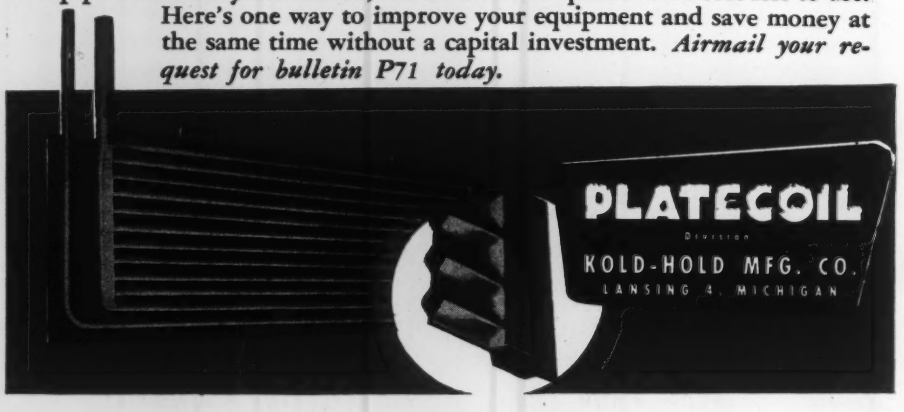
TO KEEP YOUR CASTINGS COMING . . . KEEP YOUR SCRAP GOING TO THE FOUNDRIES

The Newcomb-Detroit Company, Detroit, Michigan, has found that it costs them less money to buy and install Platecoils in their metal parts washers than it does to fabricate pipe coils in their own plant. The Platecoils can be installed in much less time by slipping them over a simple clip. Previously, large angle racks had to be built and installed when pipe coils were used.

The Platecoils offer advantages for their customers too. Where the pipe coils would occasionally develop leaks, the Platecoils are giving no trouble whatsoever, but are proving a most efficient method of heat transfer. When the pipe coils had to be removed from the tank, it was a complicated job requiring a chain hoist. If the Platecoils have to be removed, they can be lifted off the "Quick-Change" Hangers and cleaned, repaired or replaced in a hurry without dumping the solution.

Platecoils will replace pipe coils at a savings in any heat transfer application. They help conserve material as they require only 50% as much steel as pipe coils. They heat faster, can be installed quicker and cost less to use.

Here's one way to improve your equipment and save money at the same time without a capital investment. *Airmail your request for bulletin P71 today.*



SALES AND SERVICE

Personnel

FORMERLY manager of the Buffalo branch of The American Brass Co., **Justice Lockwood** has been appointed vice president in charge of sales for the entire company. His headquarters will be at the firm's main office in Waterbury, Conn. Mr. Lockwood joined Anaconda American Brass Ltd. in 1929. He was assigned to the Detroit branch in 1935 and in 1939, was appointed assistant sales manager at Buffalo. He was made Buffalo branch manager last year.

♦

C. W. Martin has been appointed die sales and service engineer for Carboloy Department of General Electric Co. in the company's Pittsburgh office.

♦

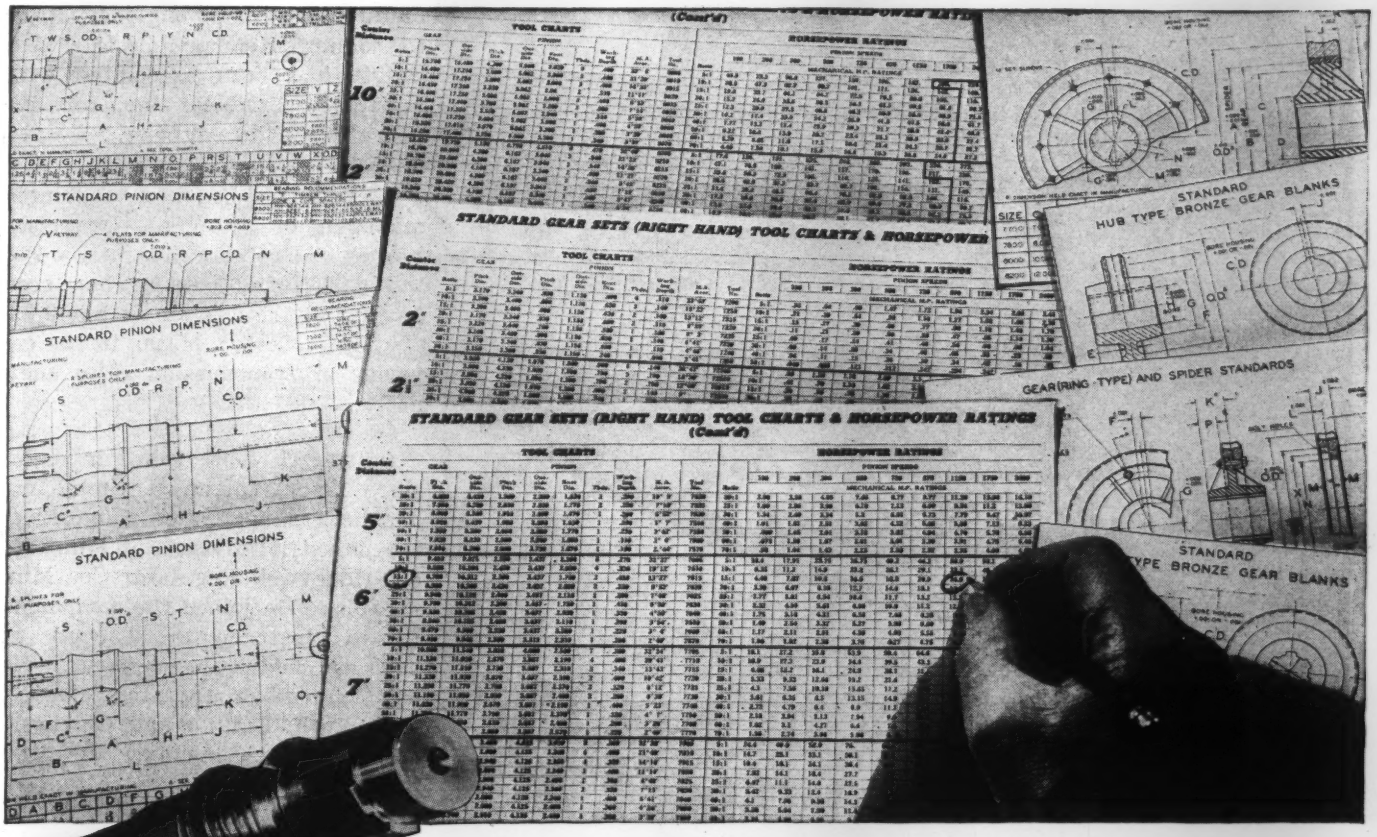
To meet increased service requirements in their southwestern territory, branch managers have been named by Carpenter Steel Co., Reading, Pa., for five mill-branch warehouses. **A. Richard Boyd** has been named branch manager in Atlanta, Ga.; **W. J. Ervin,** in Indianapolis; **W. C. Kunkelman,** in Cincinnati; **H. M. Rittger,** in St. Louis; and **R. P. Uhl,** in Dayton, O.

♦

Making his headquarters at Waterford, N. Y., **Robert J. Baumann** has been appointed sales manager of silicone products for the chemical division of General Electric Co., Pittsfield, Mass. Also, **Jerome T. Coe** has been named manager of sales development; **Robert Treat Jr.,** supervisor of customer service; and **John F. Bahm,** supervisor of sales administration and control.

♦

Kennametal Inc., Latrobe, Pa., has announced the appointment of **S. Allen Oviatt** as manager of sales engineering for Kentanium products. With headquarters at the home office, Mr. Oviatt will promote the application of this heat resistant material, particularly emphasizing its use in the manu-



Specify STANDARD Cone-Drive Gears and get all these advantages

***plus* this vital feature**

Standard *Cone-Drive gears and worms are carried in stock. Cone-Drive gears are noted for their long life—BUT if a failure should occur at any time, replacement gears and worms are available without delay.*

Ask for Catalog No. 700

Lower Cost—due to smaller size of gears and housings, mass production of worm and gear blanks, etc.

Compactness—due to distribution of load over greater contact area, reducing unit pressures. As a result, gear sets can have smaller center distances, enclosures can be smaller, etc.

Less Weight—due to smaller center distances for a given horsepower or torque. Other types of gearing weigh up to 3 times as much for the same horsepower transmitted.

Greater Smoothness—because Cone-Drive gears have more teeth in continuous contact than other forms of gearing.

Wide Range of Sizes—Center distances from 2" to 18" provide horsepower ratings from fractional up to 800 horsepower. Ratios range from 5/1 to 70/1.

CONE-DRIVE GEARS
Division, Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan

For flexible shafts—

—it pays to specify S.S.White

The success of a flexible shaft application depends on getting the right shaft for the job. This means a shaft that not only has the desired characteristics, but one that you can count on for completely dependable service, smooth troublefree operation and long service life.

You get exactly this when you specify S.S.WHITE flexible shafts. These shafts are the product of over 70 years specialized engineering, manufacturing and application experience. They're made of special grades of wire and wound on specially developed machines to conform to exacting and unvarying quality standards. Each and every foot supplied measures up to known specifications and characteristics. With an S.S.WHITE flexible shaft you know exactly what you are getting, how it will perform and what it can and cannot do. So, for flexible shafts, specify S.S.White.

SEND FOR THIS NEW 256-PAGE FLEXIBLE SHAFT HANDBOOK

Here's all the information you need on flexible shafts. It contains complete facts and data on flexible shaft construction, characteristics and application. A copy will be sent free, if you write for it on your business letterhead and mention your position.

THE S.S.White INDUSTRIAL DIVISION
DENTAL MFG. CO.
Dept. 4, 10 East 40th St.
NEW YORK 16, N. Y.

Western District Office • Times Building, Long Beach, California

facture of aircraft engines. Prior to joining Kennametal Inc., Mr. Oviatt had been associated with Thompson Products Inc. for five years as a sales engineer.

♦

Alex Reikes has been appointed manager of the San Francisco branch of Graton & Knight Co. For the past two years he has been located at the company's home office in Worcester, Mass., in the capacity of transmission sales engineer.

♦

Industrial field sales manager since 1943, **William H. Steinkamp** has been named sales manager of the industrial division of Minneapolis-Honeywell Regulator Co., Minneapolis. He joined the company's Brown Instruments division in 1930 as field sales engineer. He has served as representative in New York, Buffalo and Cleveland and as branch manager in Pittsburgh.

♦

Aeroquip Corp., Jackson, Mich., has appointed **Robert C. Colyer** as manager of Elbeeco Inc., a wholly owned subsidiary also located in Jackson. This subsidiary manufactures elbow type hose fittings.

♦

Associated with L. O. Koven & Brother Inc., Jersey City, N. J., for 26 years, **Willard P. Cunningham** has been named director of engineering sales for the company.

♦

Robert Looker has been promoted to the position of sales manager of Huck Mfg. Co., Detroit. New assistant sales manager is **Donald Stamy.**

♦

Appointment of **Gerald L. Dennis** as branch manager of West Coast operations of the Naugatuck chemical division has been announced by the United States Rubber Co., New York. Mr. Dennis will make his headquarters in the division's new plant and branch office in Los Angeles. Replacing Mr. Dennis as technical sales representative for rubber latex and dispersions in the Philadelphia area is **D. Leete Keefer,** who has been transferred from Naugatuck, Conn. Formerly assistant to the sales manager, **William J. Curtin** was appointed technical representative

NORGE ENGINEERS SAY...

STRESSPROOF® WORKS

WHERE OTHER STEELS FAIL

STRESSPROOF was selected for this transmission pinion gear for the Norge washing machine—made by NORGE Division of Borg-Warner Corporation.

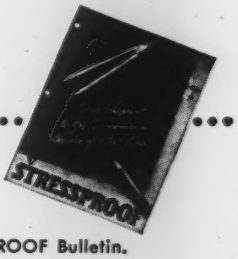
● This washing machine pinion must run for years without appreciable wear. After extensive field tests, Norge engineers found that STRESSPROOF works where other steels fail. Even heat-treated alloy, at double the cost per part, does not equal STRESSPROOF.

Then too, STRESSPROOF is used as machined. No heat treating means no distortion, with the consequent noisy operation of the washing machine. The pinions made of STRESSPROOF are clean and free of scale and require no clean-up work. They are ready for assembly as they come off the machines.

STRESSPROOF makes a better part at lower cost.

Wear resistance is only one of the four in-the-bar qualities that makes STRESSPROOF the choice for thousands of parts. *High strength*, double that of ordinary cold-finished shafting; *Machinability*, fully 50% better than heat-treated alloys of the same strength; and *Minimum warpage* in machining—are three other attributes of this unique steel.

SEND FOR Free Engineering Bulletin "New Economies in the Use of Steel Bars."



La Salle STEEL CO.

. . . the Most Complete Line of Carbon and Alloy Cold-Finished and Ground and Polished Bars in America.

La Salle Steel Co.
1426 150th Street
Hammond, Indiana

Please send me your STRESSPROOF Bulletin.

Name_____

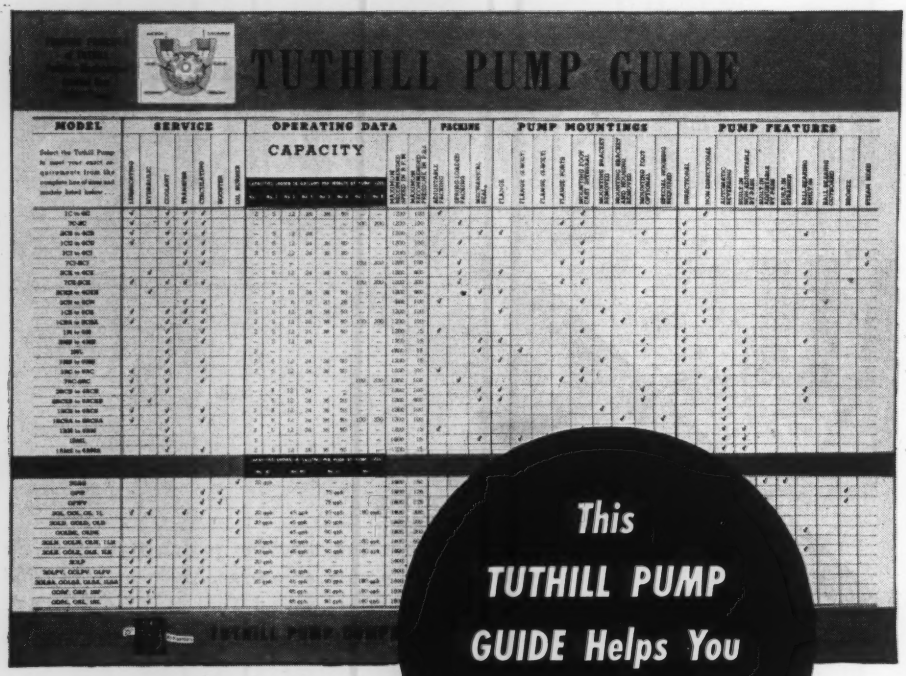
Title_____

Company_____

Address_____

City_____ Zone____ State_____

NEW EASY WAY TO SELECT THE RIGHT PUMP FOR THE JOB



This TUTHILL PUMP GUIDE Helps You Find the Answer

To save you time and trouble in selecting the pump best-suited to your application, Tuthill engineers have developed this revolutionary new Pump Guide. Here, in one easy-to-use chart, is a volume-full of information on the complete line of Tuthill Pumps.

At a glance, it shows you the services for which each model is built, together with performance characteristics, types of packing, mounting styles and distinctive features that enable you to fit the pump to your need, rather than the need to the pump.

Copies of this helpful guide are now available on request. Write for yours today—there's no obligation.

Tuthill Positive Displacement Pumps serve Industry in Lubrication, Hydraulic, Coolant, Oil Burning, Circulating and Transfer Service.

25th Anniversary TUTHILL PUMPS FOR EVERY PURPOSE

TUTHILL PUMP COMPANY

939 East 95th Street . . . Chicago 19, Illinois

in the Naugatuck area. **Lawrence H. Bruce,** formerly a process engineer in the Naugatuck chemical plant, succeeds Mr. Curtin. The United States Rubber Co. has also announced the appointment of **Harry M. Frecker** as manager of commodity sales for the mechanical goods division. Mr. Frecker was formerly development manager of the company's Passaic, N. J., plant.

♦

Thomas W. Sears Jr., 1344 Bradley Rd., Springfield, Mass., has been appointed Monsanto Chemical Co. sales representative for industrial resins in the New England territory of the company's plastics division.

♦

The appointment of two new district representatives has been announced by the Dollinger Corp., Rochester, N. Y. **Sabel E. Baum,** Dixie Engineering Co., Birmingham, Ala., has been appointed representative in Alabama, western Florida, and Marion, Hamilton, Bradley and Polk counties, Tennessee, and **Roy A. Stipp** of Greenville, S. C., is the new district representative for North Carolina, South Carolina and eastern Tennessee.

♦

Minnesota Mining and Mfg. Co., St. Paul, has appointed **Dr. Charles W. Walton** as general manager of the adhesives and coatings division, and has named **William E. Zimmerman** as general manager of the industrial tapes division.

♦

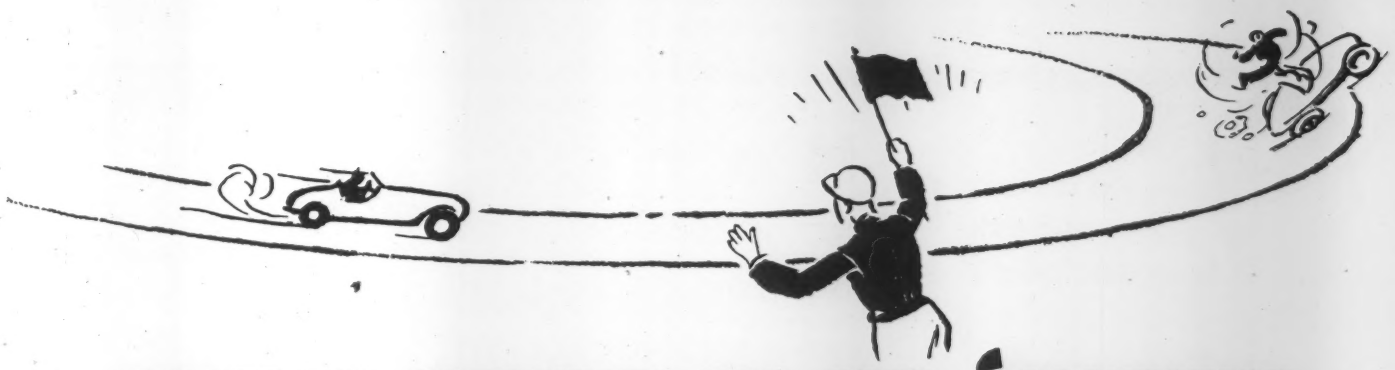
Formerly district sales manager of ACF-Brill Motors Co., **William B. McGorum** has been promoted to sales manager of the company's Hall-Scott Motor division located in Berkeley, Calif.

♦

Titeflex Inc., Newark, N. J., has appointed **William Buckley** as West Coast sales representative. Offices will be at the Salsbury Corp., 1161 East Florence Ave., Los Angeles, Calif.

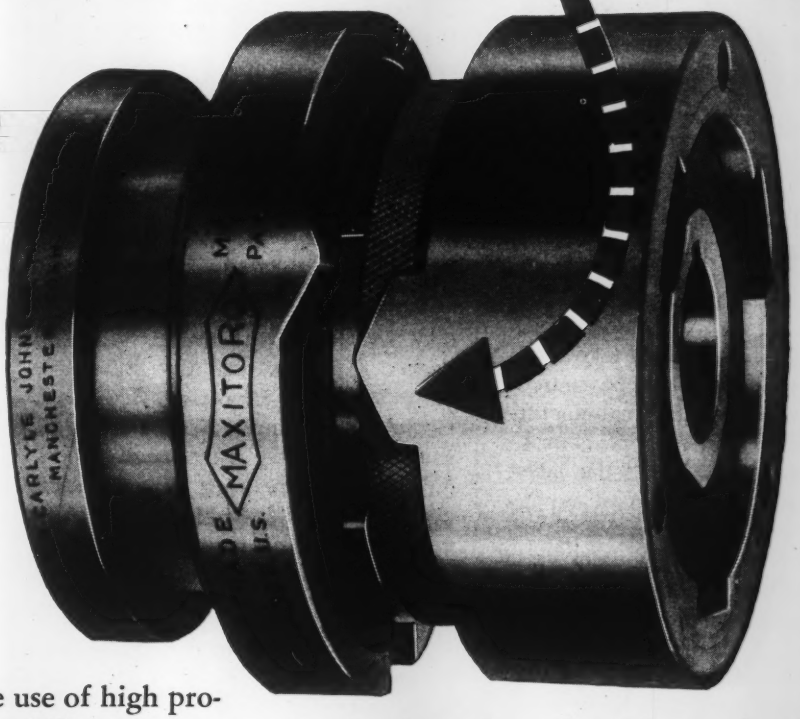
♦

John E. Newlin Jr. was recently appointed sales manager of the steel division of Henry Disston & Sons Inc., Philadelphia. He succeeds **H. D. Siegfried,** who has retired after 27 years of service with the company.



INDUSTRIAL SPEEDWAYS, TOO, NEED PROTECTION

MAXITORQ
automatic
OVERLOAD RELEASE CLUTCH



The tremendous expansion in the use of high production automatic machinery, especially in the bottling, packaging, labeling, wrapping and kindred fields, calls for added protection thru safety controls in power transmission equipment.

For this purpose we offer the Maxitorq floating disc Overload Release Clutch which automatically and instantly releases when the nature of an overload is either a heavy shock or suddenly applied load of a magnitude substantially greater than normal driving load. In such instances the machine mechanism may be clogged, products damaged and operator injured...all of which means expensive down-time.

The Overload Release Clutch performs most effectively and prevents heavy overload destruction. When jammed condition is cleared the clutch is re-engaged and operation continues. Simple fingertip adjustment sets the clutch to transmit normal running load. For original equipment, specify Maxitorq. There are six standard capacities, ¼ to 5 H.P. @ 100 r.p.m.

New catalog gives complete engineering specifications; shows complete line of standard clutches and driving cups.

ASK FOR CATALOG No. MD6

THE CARLYLE JOHNSON MACHINE COMPANY
MANCHESTER • CONNECTICUT

1CJ52

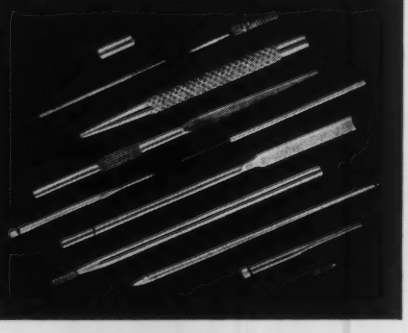
"Joe, who can make these small parts to our close 'specs'?"

"Torrington can, Tom. They have the experience and equipment to maintain precision tolerances on any quantity of small metal parts."

Small precision parts often take more production time than can be spared. That's why many leading manufacturers have turned over their parts problems to Torrington. Using the latest automatic and semi-automatic equipment, our Specialty Department produces hundreds of thousands of parts every day to the exacting specifications of hundreds of customers. These companies—some of them Torrington customers for over 40 years—have learned that they save both time and money when their small metal components are made by Torrington.

Why not send us a blueprint or sample of *your* small parts? We will quickly tell you how little it costs to have uniformly accurate components.

Typical Torrington-Made Parts



THE TORRINGTON COMPANY
Specialty Department
553 Field Street • Torrington, Conn.
Makers of
TORRINGTON NEEDLE BEARINGS

SALES Notes

FORMATION of a new special stampings department of the **Shakeproof Inc.** division of **Illinois Tool Works,** Chicago, has been announced. The purpose of the new department is to provide increased facilities for service to mass-assembly industries in the development and production of special fastenings and other small stampings. Carl F. Jensen, formerly central district sales manager for Shakeproof Inc., will head the department.

♦

Wheel Service Co., 2735 University Ave., St. Paul, Minn., has been named a midwestern distributor for the **Warner Electric Brake & Clutch Co.,** Beloit, Wis. The latter firm recently introduced an entirely new braking system for tractor-trailer combinations, featuring air brakes on the tractor and electric brakes on the trailer.

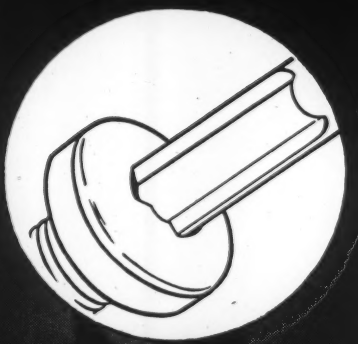
♦

A new stock carrying branch warehouse and sales office has been established by **Quaker Rubber Corp.,** division of **H. K. Porter Co. Inc.,** at 260 Schuyler Ave., Kearney, N. J., to serve the New York metropolitan area. With a floor space of approximately 9500 sq ft, the warehouse is capable of carrying an inventory of 250,000 lb of rubber products. The new branch is under the supervision of A. H. Smith, district manager for the New York area.

♦

Three new distributors were recently appointed by **Reynolds Metals Co.,** Louisville, Ky., to increase the availability of aluminum and give better service to small users. Two of these new distributors will handle the company's line of aluminum mill products, including sheet, plate, wire, rod, bar, extruded shapes, tubing and pipe, structurals, etc. They are **Vinson Supply Co.,** 3331 Haggar Dr., Dallas, Tex., serving the territory of Dallas and Odessa, Tex., and Tulsa, Okla., and **Vory's Bros. Inc.,** 65

UNITED CLUTCH HEAD® SCREWS



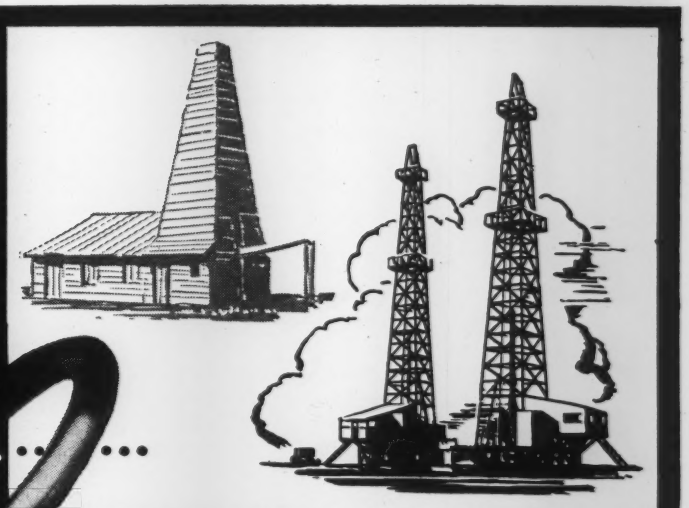
You will prevent costly damage to your assembly from screw driver "ride-out" when you specify Clutch Head* screws. Requiring the lowest "end-pressure," reduces operator fatigue and speeds up production. You will be glad you used Clutch Head screws. Write for booklet.

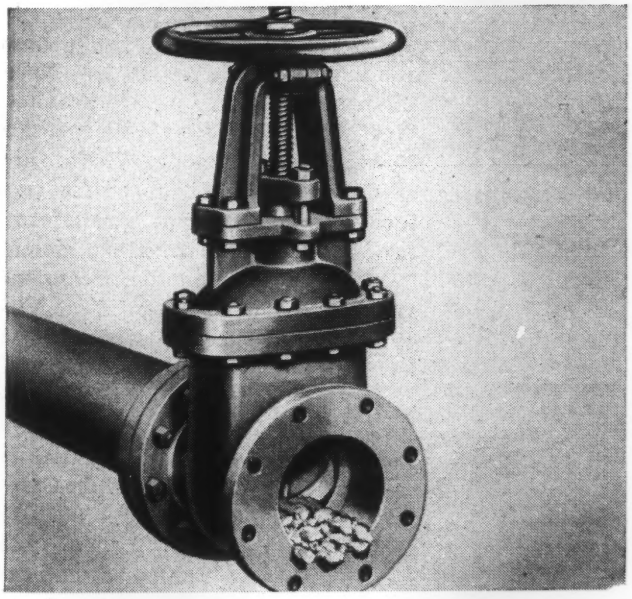
TYPE "A" BIT NOT THIS

®Reg. U.S. Pat. Off.

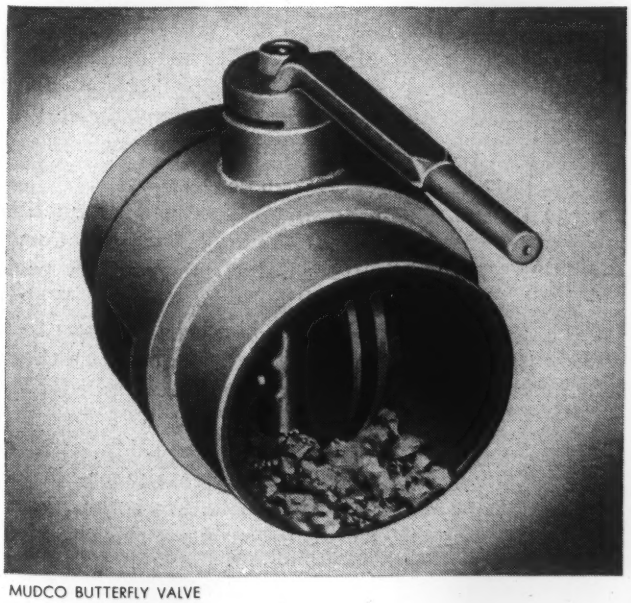
UNITED SCREW and BOLT CORP.
CHICAGO 8, ILL. • CLEVELAND 2, OHIO
NEW YORK 7, N. Y.

Results from designing for greater efficiency...





CONVENTIONAL GATE VALVE



MUDCO BUTTERFLY VALVE

More . . . MORE . . . MORE . . . *MORE* oil! *These demands* cannot be met with obsolete equipment. New, better methods and equipment must be designed to increase production, reduce "down-time" and maintenance costs!

LINEAR is playing a more important role in designing for greater oil production. For example, shale and other debris, settling in the seat of the conventional gate valve prevents a perfect seal, thus causing leakage, costly shut-downs and replacement time.

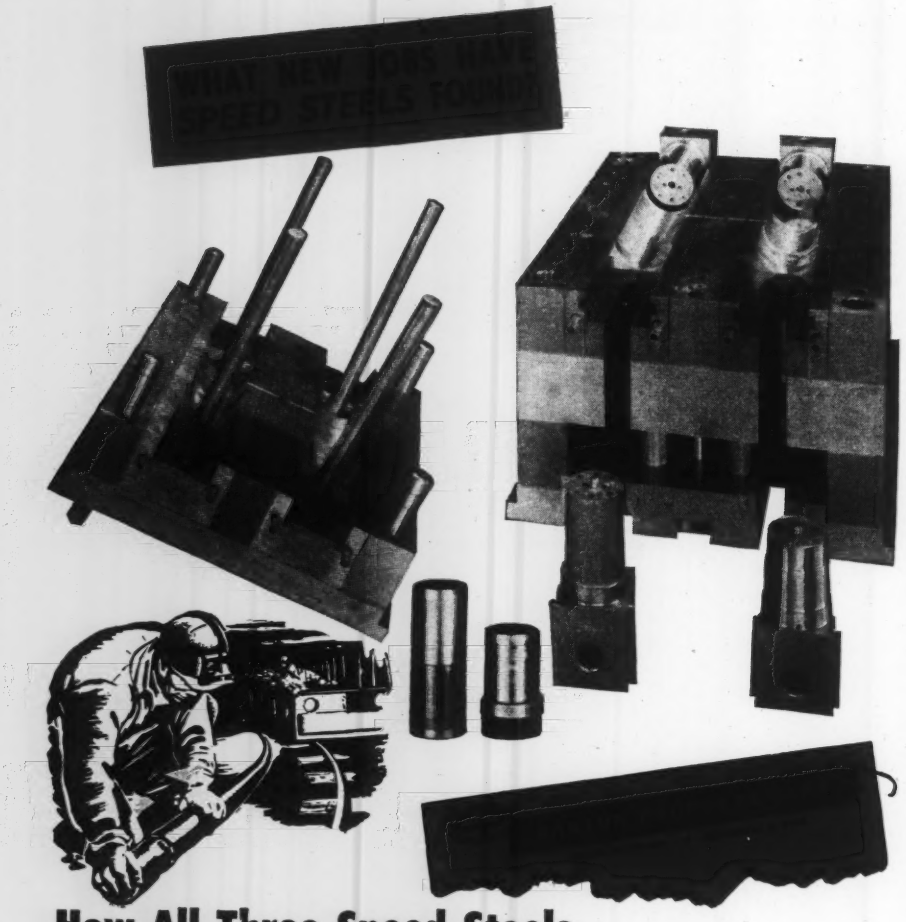
LINEAR "O" Rings, fitted to the disks of Mudco Butterfly Valves, solve the problem. During closure, the "O" ring acts as a wiper, removes the shale, and effects a tight seal. Metal-to-metal wear is entirely eliminated. And, when replacement is finally necessary, the valve is renewed simply by replacing the "O" ring *in the field* without costly machine shop repairs.

To build it better . . . make it simpler . . . to achieve greater efficiency, consult LINEAR in the design stage, to help you with your packing and sealing problems.

"PERFECTLY ENGINEERED PACKINGS"

LINEAR

LINEAR, Inc., STATE ROAD & LEVICK ST., PHILADELPHIA 35, PA.



How All Three Speed Steels Make Plastic Pipe More "Flexible"

Carlon is a plastic pipe used to transmit fluids and vapors over irregular surfaces. This Speed Steel Mold—using Holliday's Speed Case (X1515), Speed Treat (X1545) and Speed Alloy hot rolled alloy plate steel helps make Carlon even more "flexible". It molds 6" dia. threaded plastic couplings that join either long lengths of Carlon to Carlon or Carlon to standard metal pipe.

Naturally, these couplings have to be near-perfect to prevent leakage. Carlon Products Corp. reports top distortion-free production at the rate of one shot per minute. Houk Machine Company, Barberton, Ohio who made the mold of Speed Steels for Carlon, reports 40% faster machining than regular hot rolled carbon or tool steels plus an absence of warpage and distortion and longer tool life. Top and bottom plates are of ground Speed Treat plate, male and female core are of Speed Case carburized to Rockwell 55 "C" then ground to size. Other parts are of Speed Alloy.

How versatile Speed Steels are solving new fabricating problems every day makes mighty profitable listening. Check with your Speed Steel distributor or write direct for literature.

SPEED STEELS

SPEED ALLOY ■ SPEED CASE ■ SPEED TREAT

DISTRIBUTED BY

Brown-Wales Co., Boston-Hartford-Lewiston, Me. ■ Bridgeport Steel Co., Bridgeport, Conn. Beals, McCarthy & Rogers, Buffalo, N. Y. ■ Burger Iron Co., Akron, Ohio ■ Grammer, Dempsey & Hudson, Inc., Newark, N. J. ■ Earle M. Jorgensen Co., Los Angeles-Houston-Oakland-Dallas ■ Passaic County Steel Service, Inc., Paterson, N. J. ■ Peckover's Ltd., Halifax-Montreal-Toronto-Winnipeg-Vancouver ■ Peninsular Steel Co., Detroit, Mich. Pidgeon-Thomas Iron Co., Memphis, Tenn. ■ Horace T. Potts Co., Philadelphia-Baltimore

Produced by W. J. Holliday & Co., Inc., Speed Steel Plate Division, Hammond, Indiana. Plants: Hammond and Indianapolis, Indiana

East Goodale St., Columbus 8, O., serving central and southern Ohio, western West Virginia, and eastern Kentucky. The third appointment, for the distribution of ingot products only, is **G. A. Avril Smelting Corp.,** Este Ave. and B & O Railroad, Cincinnati, O., representing Reynolds in Kentucky, south-central Ohio, southeastern Indiana, western West Virginia and northern Tennessee.

♦

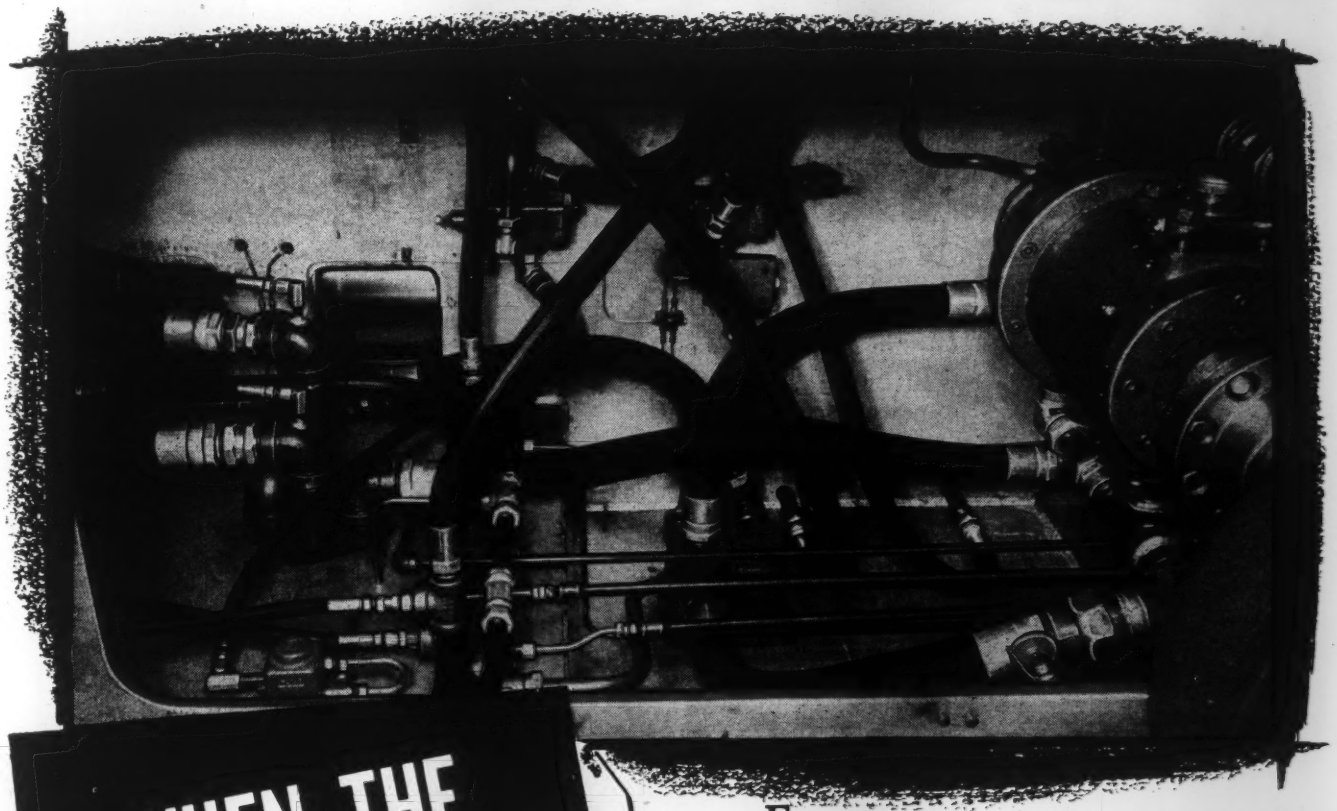
A. Milne & Co., New York, has opened a new sales office at 915 Fisher Bldg., Detroit 2, Mich. The new office will be under the management of W. T. Nagorsen, who will supervise sales of the company's line of solid and hollow tool steels in the Detroit area.

♦

Several appointments have been announced recently by **Allis-Chalmers Mfg. Co.,** Milwaukee. **West Virginia Electric Corp.,** 208 Newton St., Fairmont, W. Va., has been named a distributor for motors, controls, pumps, transformers and Texrope drive equipment in Marion, Monongalia, Harrison and Preston counties in West Virginia. **Kahn Electric Motor Service,** 1024 Charlieville Place, St. Louis, is a new distributor for motors and controls in the city of St. Louis, as well as in 15 counties in eastern Missouri. **Virginia-Carolina Electrical Sales Inc.,** 1000-1014 East Main St., Norfolk, Va., will distribute Allis-Chalmers motors and pumps in nine southeastern Virginia counties, and **Mercury Hardware Co.,** 11203 Garvey Ave., El Monte, Calif., has been named a distributor for Texrope drive equipment in the San Gabriel Valley in Los Angeles county.

♦

Because of increased production facilities, **Lamb Rubber Corp.,** Glendale, Calif., is now in a position to supply its line of Whirlaway rubber-bonded abrasives to a national market. Heretofore these abrasives have been supplied only to a limited number of large manufacturers. In addition to a standard line of rubber-bonded abrasive products, the company offers an engineering service to supply industrial users with custom made abrasives to meet specific job requirements.



WHEN THE PRESSURE'S ON

easily, efficiently, safely

EXTRA safety, unusual dependability — that's what the manufacturer of this 25-ton 66" Double Ram wanted. And that's why he specified Anchor Ductile Sleeve Couplings and Hose. Like many other manufacturers of machinery using hydraulic systems, he knows Anchor's exclusive patented grip makes the coupling virtually a part of the steel reinforcing wire of the hose — eliminates leaks and troublesome blow-offs.

HERE ARE ADDITIONAL REASONS why Anchor two-wire braid high-pressure hose assemblies were selected for this tough job:

- They reduce maintenance and service on piping to practically nothing.
- They are unusually easy to install — save fitting time, cut assembly costs.
- They provide maximum operating efficiency.

Anchor also makes a complete line of adapter unions and related fittings for practically every pressure or suction job. Take advantage of the many outstanding features in the most complete line of hose assemblies and fittings available. Benefit by the plus margin of safety and the greater dependability offered by Anchor.

Attach Coupon to Your Letterhead and Mail Today

ANCHOR COUPLING CO. INC.
Factory: LIBERTYVILLE, ILLINOIS
Branches: DETROIT, MICHIGAN
DALLAS, TEXAS

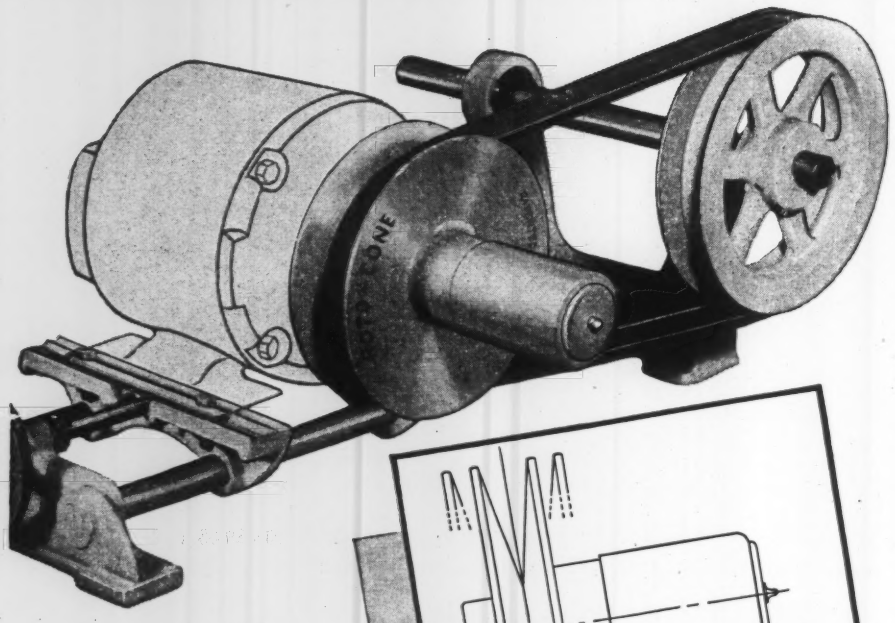
ANCHOR COUPLING CO. INC., Dept. MD-62
Libertyville, Illinois

Yes, I'm interested in Anchor Ductile Sleeve Hose Assemblies and Fittings. Send me catalog sheets.

Name.....Position.....
Company.....
Company Address.....
City.....(.....) State.....

B-12

ROTO-CONE
VARIABLE SPEED DEVICES



INDUSTRY'S

Finest...

YET MOST ECONOMICAL
VARIABLE SPEED PULLEYS AND DRIVES

Smooth, infinitely variable speed can be yours with Roto-Cone, industry's finest, yet most economical V to V variable speed drives. Positive rack and pinion arrangement, *exclusive* in Roto-Cone variable speed motor pulley, provides equal and opposite lateral movement of both discs, therefore, V-belt always travels on a fixed center line. Pulleys are dynamically and statically balanced and do not have interlocking sheaves. Result is maximum vibrationless transmission of power and full belt life.

The Roto-Cone line is complete . . . variable speed pulleys, adjustable motor bases, V-belts, and V-driven sheaves . . . All tested and proven on thousands of actual installations.

Yes . . . you can easily add productivity or saleability to your present drive with Roto-Cone. Up to 4 to 1 speed-change ratios are available. Wide selection of sizes from ⅛ to 15 H.P. Write for details and request the assistance of our speed control engineers.

ROTO-CONE
Complete VARIABLE SPEED DRIVES

GERBING MANUFACTURING CORP.

NORTHBROOK, ILL. (A Suburb of Chicago) Dept. C-RC

Meetings

AND EXPOSITIONS

June 9-21—

International Organization for Standardization. Triennial meeting to be held at Columbia University, New York, N. Y. The American Standards Association, U. S. member of the ISO, will act as host. Additional information may be obtained from American Standards Association, 70 East 45th St., New York 17, N. Y.

June 15-19—

American Society of Mechanical Engineers. Semiannual meeting to be held at the Sheraton-Gibson Hotel, Cincinnati, O. C. E. Davies, 29 West 39th St., New York, N. Y. is secretary.

June 16-17—

Malleable Founders' Society. Annual meeting to be held at the Homestead Hotel, Hot Springs Va. Additional information may be obtained from society headquarters, 1800 Union Commerce Bldg., Cleveland, Ohio.

June 16-18—

American Society of Agricultural Engineers. 45th annual meeting to be held at the Muehlebach Hotel, Kansas City, Mo. Raymond Olney, P. O. Box 229, St. Joseph, Mich., is secretary.

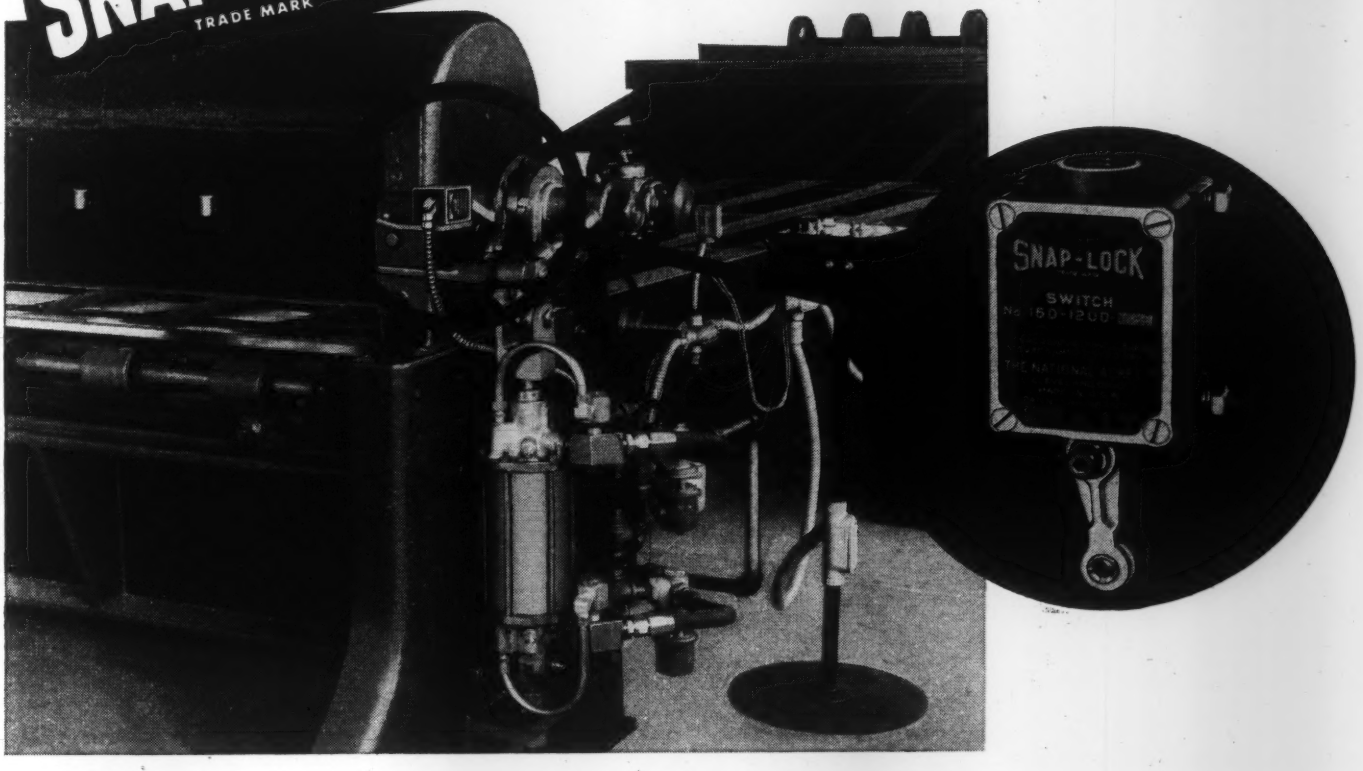
June 16-20—

American Electroplaters' Society. Third Industrial Finishing Exposition to be held at the International Amphitheatre, Chicago, Ill. This meeting is being held in conjunction with the 39th annual meeting of the AES which will take place at the Conrad Hilton Hotel, Chicago, Ill. Additional information may be obtained from society headquarters, 35 East Wacker Drive, Chicago 1, Ill.

June 19-21—

American Society of Mechanical Engineers. Applied mechanics division conference to be held at Pennsylvania State College, State

SNAP-LOCK TRADE MARK for Split-Second* Precision



*400 OPERATIONS PER MINUTE ON THIS COE VENEER CLIPPER

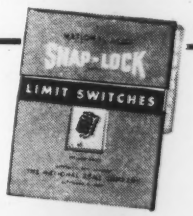
The Coe Manufacturing Company, "world's largest makers of veneer machinery," have devised their own special type of torture test for limit switches in their new air-operated veneer clipping machine. No ordinary switch could survive the ordeal of operating 400 times a minute under such heavy duty service.

Snap-Lock passed the test with flying colors! Its record of dependability is renowned; over 80% of the nation's machine tool builders have standardized on Snap-Lock for dependable service.

Here are the exclusive design and construction features that have contributed to this outstanding acceptance record:

1. Separate sealed electrical and mechanical sides (for added safety)
2. Hardened steel moving parts (for greater strength, longer life)
3. Positive on or off locking (can't stop on dead center)
4. SNAP make and break (fast acting — accurate)
5. Coin silver self-wiping contacts (no arcing)

Snap-Lock Limit Switches are built in a variety of types and sizes, to suit every industrial application; special mountings are available. May we show you how they can be designed into your product?



The complete range of Namco standard Snap-Lock Limit Switches is illustrated and tabulated in our new engineering bulletin EM-51. Be sure to get your copy.

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Acme-Gridley Bar and Chucking Automatics: 1-4-6 and 8 Spindle • Hydraulic Thread Rolling Machines • Automatic Threading Dies and Taps • The Chronolog-Limit, Motor Starter and Control Station Switches • Solenoids Centrifuges • Contract Manufacturing

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College, Pa. C. E. Davies, 29 West 39th St., New York, N. Y. is secretary.

June 23-27—

American Society for Testing Materials. The 50th annual meeting to be held at the Hotel Statler, New York, N. Y. Additional information may be obtained from society headquarters, 1916 Race St., Philadelphia 3, Pa.

June 23-27—

American Society for Engineering Education. Annual meeting to be held at Dartmouth College, Hanover, N. H. A. B. Bronwell, Northwestern University, Evanston, Ill., is secretary.

June 23-27—

American Institute of Electrical Engineers. Summer meeting to be held at Hotel Nicollet, Minneapolis, Minn. H. H. Henline, 33 West 39th St., New York 18, N. Y., is secretary.

June 23-27—

American Society of Mechanical Engineers. Oil and Gas Power Division conference to be held at Hotel Statler, Buffalo, N. Y. C. E. Davies, 29 West 39th St., New York 18, N. Y., is secretary.

Sept. 4-5—

National Conference on Industrial Hydraulics. Eighth annual meeting to be held at the Sherman Hotel, Chicago, Ill. J. G. Duba, Illinois Institute of Technology, Technology Center, Chicago 16, Ill., is secretary.

Sept. 8-10—

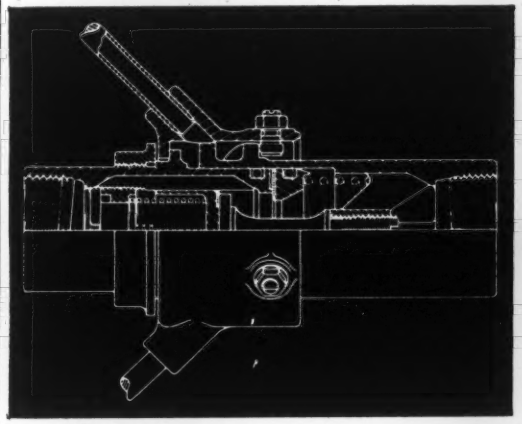
American Standards Association. Third National Standardization Conference will be held in conjunction with the Centennial of Engineering at the Museum of Science and Industry, Chicago, Ill. Additional information may be obtained from society headquarters, 70 East 45th St., New York 17, N. Y.

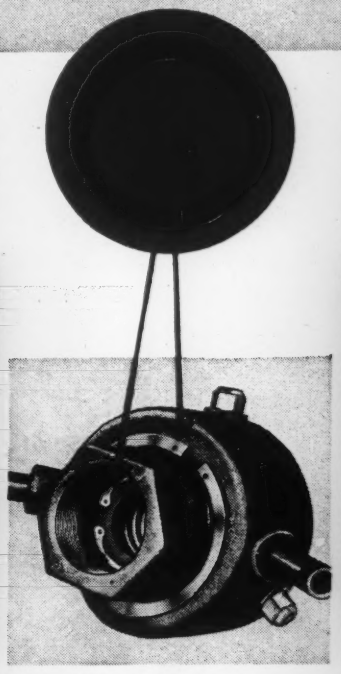
Sept. 8-11—

American Society of Mechanical Engineers. Fall meeting to be held at the Sheraton Hotel, Chicago, Ill. C. E. Davies, 29 West 39th St., New York, N. Y., is secretary.

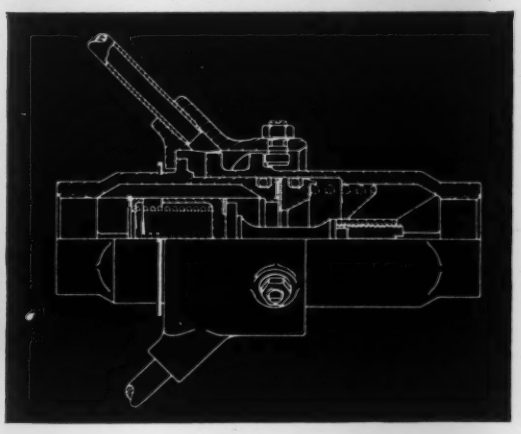
2 TRUARC RINGS
ELIMINATE BULKY THREADED RETAINERS
...SAVE 41 MINUTES...$4.02 PER UNIT

OLD WAY Oversize internal and external retainers required costly milling, turning and threading operations. Assembly and disassembly (for inspection and seal replacement) was slow, difficult and expensive. Wall thickness and weight were excessive.





NEW WAY An internal (series 5000) and an external (series 5108) Truarc Ring are set into 2 grooves. Light, strong, economical Truarc Rings simplify assembly, disassembly, maintenance. Unit is smaller, more efficient. Greater accuracy because of positive stop positions!



Sperry Products, Inc., Danbury, Conn., saved 41 minutes in manufacturing and assembly time by using 2 Waldes Truarc Retaining Rings in place of old-fashioned threaded retainers in their self-sealing couplings! With Truarc Rings many tooling operations were eliminated... important savings per unit were made in raw material (1½ lbs. metal), overall size (3/16" diam.), and weight (1 lb.). Unit efficiency was greatly increased!

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outer shoulder ring: 15 minutes	$1.12
inner retainer: 20 minutes	1.50
threading: 4 minutes	.30
ASSEMBLY	.13
Total labor savings	$3.05
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TOTAL SAVINGS WITH TRUARC RINGS	**$4.02**

For precision internal grooving and undercutting... Waldes Grooving Tool.

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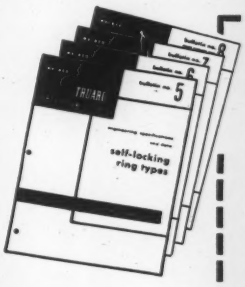

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WALDES TRUARC RETAINING RINGS AND PLIERS ARE PROTECTED BY ONE OR MORE OF THE FOLLOWING U.S. PATENTS: 2,382,947; 2,382,948; 2,416,852; 2,420,921; 2,428,341; 2,439,785; 2,441,846; 2,455,165; 2,483,380; 2,483,383; 2,487,802; 2,487,803; 2,491,306; 2,509,081 AND OTHER PATENTS PENDING.

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Please send engineering specifications and data on Waldes Truarc Retaining Ring types checked below. MD-064

- ☐ Bulletin #5 Self-locking ring types
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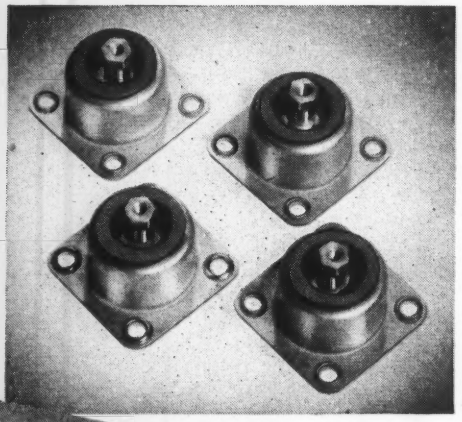
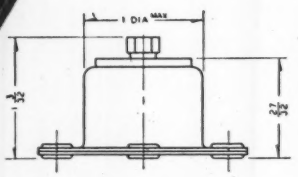


Photo courtesy Vapor Heating Corp.



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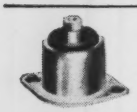
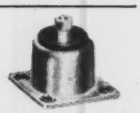

TYPE 6465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For complete information, ask for Barry Catalog 523-A; it's free on request. And for greatest benefits with miniature Barrymounts, let our Field Engineering Service share our experience with you in the early stages of your designs.

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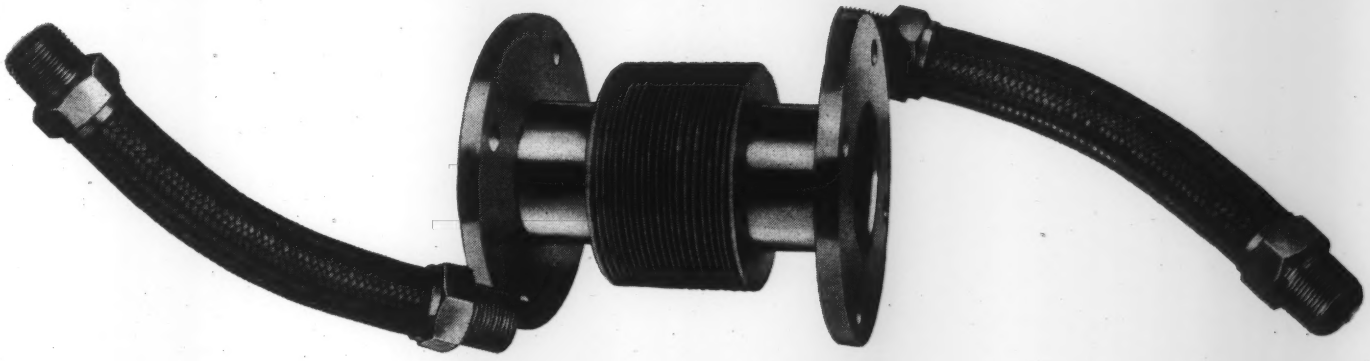
Automatic Metal Loader: Detachable cart raises load of metal, dumps it, and returns to loading position. Eliminates heavy hand-loading and fumes common to manual operation. Adaptable for any make of melting pot. *C. M. Kemp Mfg. Co., Baltimore, Md.*

Scrap Eliminator: Permits shear operator to discard trim cuts without leaving his position at the shear controls. Operation of hand lever deflects air-operated tilt table, causing rejects to be diverted into scrap box. Reverse lever movement returns table to original position. Designed for use with Fried Stripveyor or Liftveyor. *Fried Steel Equipment Mfg. Corp., New York, N. Y.*

Portable Unloader: For automatic removal of small parts for small and medium size presses. Can be adjusted up or down to reach various die levels and can be set at any angle required. Jaw travel is in a straight line and is especially suited for removal of small parts at high speed. Mounted on

Are these 3 new to you?



It would pay you to know all about them

Don't let their modest appearance fool you; these are puzzle-busters and job-simplifiers extraordinary.

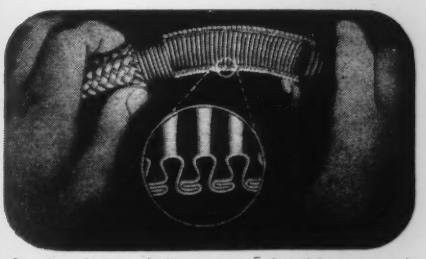
This is **TITEFLEX®**—*the* All-Metal Flexible Hose with 1001 industrial applications. It withstands temperatures, pressures, vacuum, vibration and the corrosive action of a host of liquids and gases. How can you use it? To connect moving parts of machinery. To connect misaligned parts. To absorb vibration, contraction, expansion and pulsation. To "transmit" vacuums or convey high-frequency currents. To shield wire and cables. And to handle difficult materials—from acid and ammonia to sea water or steam.

Here's **UNIFLEX**—the new *Helically-corrugated* Seamless Flexible Tube. It's tough, corrosion-resistant, leak-proof. And its *helical* construction gives it greater flexibility and longer life in applications too critical for ordinary concentric tubing. UNIFLEX is for you—if you're concerned with hydraulic lines, oil burners, refrigeration machinery, air conditioning equipment, pumps, compressors, diesels or machine tools. For leakless service, UNIFLEX fittings have metal-to-metal seat. Seal is produced through spring washer effect of hose on fitting body.

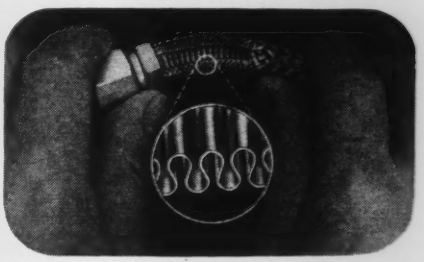
TITEFLEX BELLOWS are the *efficient* means of absorbing lineal movement in many types of equipment. Their welded, convoluted-diaphragm construction lets them do this without weakening the lines in which they are inserted and without reducing the flow rates of gases or liquids being conveyed. You can use TITEFLEX BELLOWS to seal high pressure valves and shafts, accommodate lineal contraction and expansion or high frequency vibration, and to handle gases and corrosive liquids under high temperature conditions. Special designs are available and complete bellows assemblies can be furnished with any required types of fittings.

Get the facts without obligation

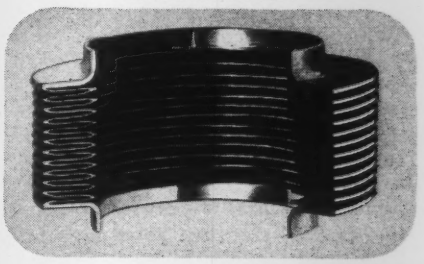
TITEFLEX literature contains full descriptions, technical data and suggestions for use. And Titeflex Designers and Engineers have a thorough knowledge of these products' behavior under exacting service conditions. Check the products that interest you and mail the coupon today. We'll be glad to help you with any specific problem.



Sectional view shows rugged, flexible, seamed construction of Titeflex.



Note the helically-corrugated, seamless wall structure of Uniflex.



Cross-section shows the welded, convoluted-diaphragm construction of Titeflex Bellows.

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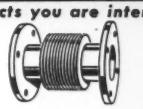

☐ PRECISION BELLOWS

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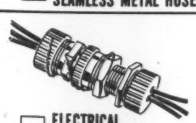
☐ IGNITION SHIELDING



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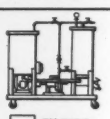

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heavy steel frame with four caster type wheels. Has built-in locking device. Operation is as follows: When ram ascends after forming or shearing operation, steel jaw of unloader moves into die and takes a firm hold on the stamping. Jaw lifts stamping, moves back out of die and drops stamping into a tote box or onto a conveyor, then returns to original position. Various types of gripping jaw designs are available. *Sahlin Engineering Co., Birmingham, Mich.*

Carton Lift: Does not use pallets. Two cartons are lifted simultaneously by placing unit in contact with bottom carton and raising the carriage. Spade-like arms move up and under carton's interlocking cover flange. Arms adjust laterally to handle cartons of varying widths. Unit is interchangeable with standard forks. *Towmotor Corp., Cleveland, O.*

Vibrating Spreader Feeder: For providing a continuous curtain of bulk materials. Consists of a flat pan trough having a diagonal slot and powered by a single electromagnet drive which may be mounted either above or below trough. Rate of feed is controlled by rheostat adjustment. Vibratory action flows material out along trough, discharging it along edge of slot to form a constant curtain of material 2 to 4 times the width of the original material stream. Available in several sizes and capacities. *Syntron Co., Homer City, Pa.*

Metalworking

Wheel Forming Attachment: Portable Model 4 Diaform designed to simplify form-truing of grinding wheels up to 20-in. diameter, used on medium and heavy-duty, horizontal spindle, surface grinders. Offers quick, accurate method of truing a given form up to 3 in. wide and 1 in. deep in one setting. Vertical pantograph is operated by tracing from a 5:1 ratio template to guide a truing diamond across face of grinding wheel. Three diamonds mounted in tandem are employed to true a new form on a wheel—one for roughing, one for semifinishing, and one for finish truing. Available in both right-hand and left-hand models for use on machines with either clockwise or

Every small worm gear unit is built to precision standards—as outstanding in quality and performance as larger size Clevelands.
Illustrated above are the 10 AT (left) and 00 D (right) speed reducers.

Enjoy the benefits of worm gear drives in smaller CLEVELAND speed reducers

WHEN you want a quiet, powerful, dependable drive for a small machine, choose a Cleveland Worm Gear Speed Reducer.

As built by Cleveland, the worm gear reducer is a drive of many advantages:

1. It is compact and inherently quiet, transmitting power with smooth, uninterrupted torque flow.
2. Its right-angled design saves valuable space.
3. It has a minimum of moving parts.
4. Shock load resistance and other factors of safety are high.
5. Rate of wear of case hardened steel worm on nickel-bronze gear is very low, insuring long life.

Write for Bulletin 114F which illustrates and gives engineering data on smaller size Clevelands—many now available for immediate delivery. The Cleveland Worm and Gear Company, 3265 E. 80th St., Cleveland 4, O.

Affiliate: The Farval Corporation, Centralized Systems of Lubrication. In Canada: Peacock Brothers Limited.

CLEVELAND
Speed Reducers

counterclockwise wheel rotation, respectively. *Pratt & Whitney, Div. Niles-Bement-Pond Co., West Hartford, Conn.*

Tube Mills: For producing electrically welded tubing of the principal nonferrous metals, including practically all aluminum alloys available in coiled sheet form, copper alloys, various brasses, nickel, monel, inconel and stainless steels. Produces tube comparable in quality to conventional resistance-welded steel tubing. Three sizes of mills are available, having a total capacity range of ¾ to 8-in. diameter, on metal thicknesses ranging from 0.025 to 0.140 in. Welding speeds of 50 to 90 fpm. *The Yoder Co., Cleveland, O.*

Vertical Milling Machine: Built by Technica, A. G., Grenchen, Switzerland, for precision work on small parts. Especially designed for serial milling of grooves, slits, slashings, jointseats, etc. Milling spindle with collet, SV 12 F, capacity 5/16 in.; milling spindle with Morse taper, No. 1. Maximum spindle speed, about 6000 rpm. Diameter of milling table, 5 in. Transverse movement of milling table, 1 9/16 in.; longitudinal movement of milling table, 2 in. Weight, 165 lb. *Carl Hirschmann Co., Manhasset, N. Y.*

Hand Screw Machine: For both low-speed production work and high-precision secondary operations. Features extreme ruggedness with a range of slow spindle speeds for heavy roughing operations and high accuracy with fast spindle speeds for small diameter, close tolerance work. Spindle speed range is from 184 to 3796 rpm in 16 steps. Four-position quick-change gear box makes instant speed selection possible. Spindle powered by 1-hp, two-speed, instant-reversing motor. Has one-piece 40¼-in. bed with 6-in. hardened ways. Length of bed to headstock, 31½ in.; clearance from nose of spindle to face of turret, 18⅞ in. Spindle has 1 7/16-in. bore and accommodates work up to 1-in. diameter with bar type collet closers, and 1⅜-in. using nose type collet closers. *Globe Heat-Seal Inc., Los Angeles, Calif.*

Horizontal Boring Mill: Has 18 feeds with rapid traverse on all slides. Features infinite control of feeds on facing head and heavy 10-

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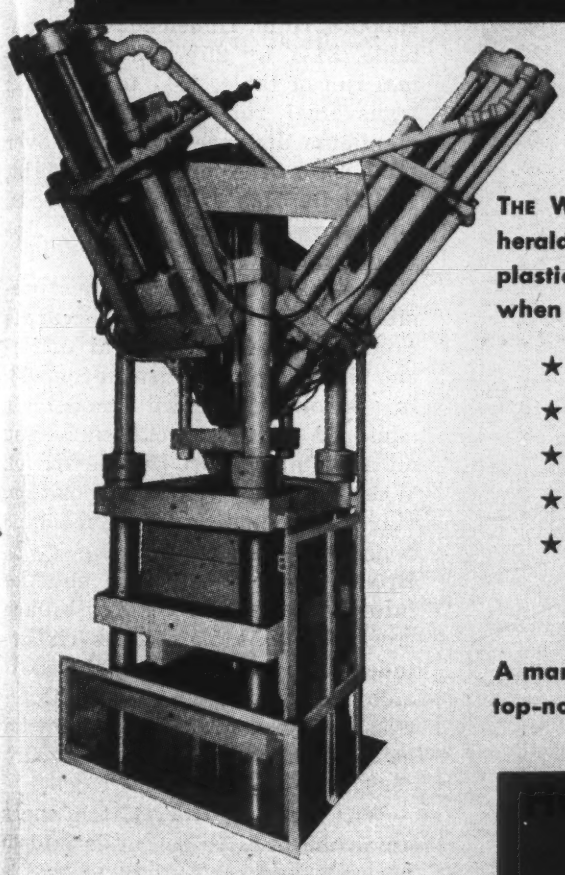
FROM THIS WORLD'S BIGGEST VERTICAL INJECTION MOULDER!



THE WORCESTER MOULDED PLASTICS COMPANY, Worcester, Mass., is heralded everywhere for designing and producing this injection plastic moulder said to be the world's largest. And no wonder, when you look at the facts...

- ★ **3 stories high—3 years to engineer and build!**
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That's why we make sure that Houghton packings are design-engineered for a perfect fit. And continuing research guarantees the finest in materials and craftsmanship.

The Houghton line offers you packings for practically every hydraulic and pneumatic need, as the list at the left will show. Includes Hydro-Drive Hydraulic Oil, too, the "fortified" lubricant developed for extra oxidation stability, corrosion resistance and greatest efficiency in use with Houghton Packings.

Why not talk over your packing problems with the Houghton Man? It can be a big step towards further product improvement. Or get further information by writing to E. F. Houghton & Co., Philadelphia 33, Pa.

VIM LEATHER PACKINGS...
Cups, flange, "U", "V"—flat washers, discs and gaskets—for oil, air, water or gas pressures—in hydraulic or pneumatic equipment, pumps, valves, etc.

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Homogeneous and fabricated packings, gaskets and adaptors, also "O" rings and VIM Leather back-up washers designed for use with them.

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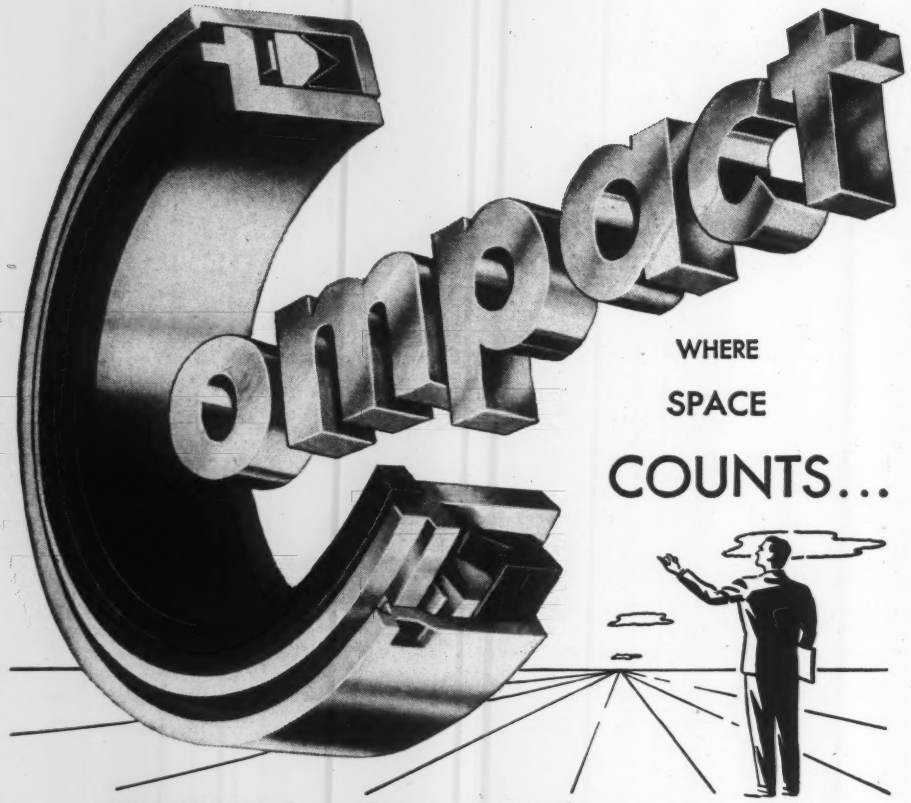

. . . "SEALOL" Balanced Pressure Seals are at a premium.

Because they are so compact and require so little radial and axial space, "Sealol" Seals shrink housing dimensions, keep shaft lengths to a minimum, and permit the location of bearings closer to the load.

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A Shaft Dia.	B Seal O.D.	C Axial Length *Seal only*
½"	1.001"	.437"
1"	1.626"	.531"
1½"	2.188"	.563"
2"	2.751"	.593"
3"	3.939"	.875"
4"	5.127"	.938"

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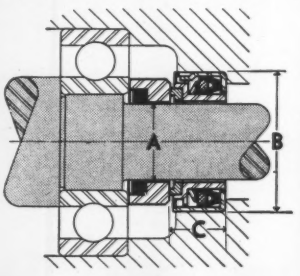

SEALOL

The Balanced Pressure Seal

hp motor with amperage load regulator. Diameter of spindle, 3 in.; taper, Morse No. 5. Spindle maximum run, 32¼ in. Diameter of platform, 25 in.; maximum distance from platform to counter support, 70 in. Dimensions of turntable, 34¼ by 25¼ in. Longitudinal run of table, 45¼ to 57⅞ in.; transversal run of table, 24 in. Maximum distance of spindle over table, 29⅞ in. Approximate weight, 10,120 lb. Has 16 spindle speeds. *Diamond Machine Tool Co., Los Angeles, Calif.*

Broaching Machine: Makes possible the production of accurate tapered splines on several different sizes of parts. Fifteen-ton, 66-in. stroke pulldown model is equipped with a special table and an adjustable short shuttle travel. When part is clamped in position, start button is pressed and machine begins automatic operating cycle. Broach travels up, table shuttles into position for broaching, broach travels down, table recedes, fixture indexes to position for the next spline, and the cycle repeats. Operation is hydraulic throughout with electrical controls. *Colonial Broach Co., Detroit, Mich.*

Wire Rope Cutter: Latch opens anvil, material to be cut is laid in position, and main body of tool is raised back to vertical position which automatically locks tool in cutting position. Exerts up to 50 tons thrust which makes clean cut through up to 1¾-in. wire rope. Heavy-duty shear blades are easily removable for resharpening. Available with a variety of electric and air-driven hydraulic pump assemblies, and foot lever for remote control operation. Weight of unit, 75 lb. *Manco Mfg. Co., Bradley, Ill.*

Multi-purpose Machine: Hommel Universal machine tool can be used to machine complicated workpieces on all sides, usually without changing original setting position. Many special attachments and tools available, and all parts are interchangeable. With various attachments, can be used for precision turning, facing, milling, grinding, drilling, planing, jig boring, polishing, slotting, and a variety of other jobs. Base plate can be used as a tracing plate and a measuring table. Drive system can be set up for 25 different spindle speeds and operates in any position. Spin-

dle headstock has self-adjusting roller bearings, and the spindle bore fits a face plate or three-jaw chuck with the same dimensions as the dividing head, enabling the use of interchangeable clamping devices. *Morey Machinery Co. Inc., New York, N. Y.*

Surface Broaching Machine: Vertical hydraulic unit has 72-in. stroke; exerts 15-ton pressure. Equipped with new type fixed hydraulic cylinder to operate work slide, which is guided in adjustable hardened and ground ways. Has receding work table and an automatic indexing unit. Also available with 90 and 120-in. stroke. *American Broach and Machine Co., Ann Arbor, Mich.*

Soldering Gun: Transformer type heats in 3 to 5 seconds when trigger is pressed; cools when trigger is released. Built-in spotlight illuminates work. Operates on 110 to 120-v ac current, uses 250w. *Wen Products Inc., Chicago, Ill.*

Gear Hobber: Redesigned for production hobbing of small gears. Features handwheel-operated draw bar collet which reduces time required for loading and unloading, and adjustable spindle nose which assures accuracy of workpiece to within 0.0001-in. and simplifies necessary adjustment for accuracy when change is made from collet to work holding fixture. *The Hamilton Tool Co., Hamilton, O.*

Shapers: Models now equipped with electromagnetic clutches and brakes as standard equipment, insuring instant starting and stopping with finger tip control lever. Ram can be positioned quickly and accurately for setting tools by instant action of clutch and brake. *The Cincinnati Shaper Co., Cincinnati, O.*

Plant Equipment

Portable Dust Collector: Especially designed for remotely located individual dust sources such as grinders, polishers, sanders, buffers, etc. Develops a rated 525 cfm at a static suction of 2-in. water lift. Has paddlewheel, self-clearing fan driven by a 1/3-hp continuous-duty motor. Operates on 110-v, single-phase, or 220-v or 440-v, three-phase, 60-cycle cur-

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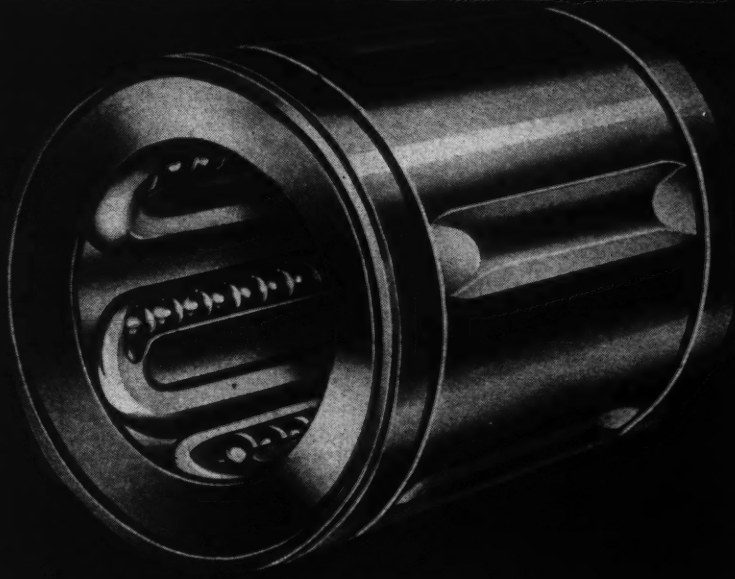

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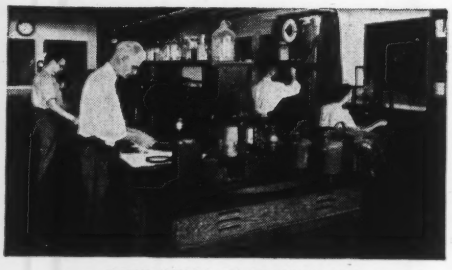

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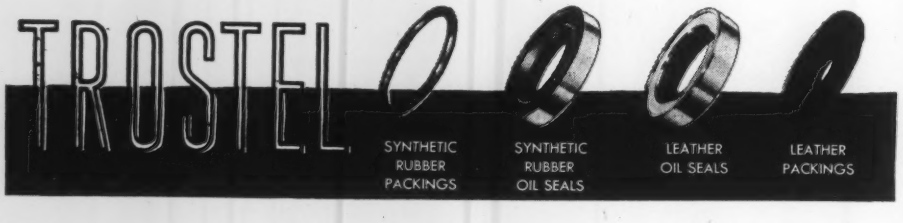

rent. Built-in cyclone separator removes all dusts down to 20 micron size and precipitates them into dust storage compartment which comprises base of unit. Remainder of dusts are removed from air stream by spun glass filter which comprises top of unit. Size: 18 by 23-in. base; 25 in. high. *Aget-Detroit Co., Ann Arbor, Mich.*

Separator: For removing parts from deburring and finishing chips, and for grading different sizes of chips. Hopper is located at top of machine. Two-deck carriage permits grading three sizes of chips simultaneously. Inclined end of screen carriage is motivated by an eccentric; lower end rests on ball bearing rollers. Eccentric action or throw of screen is blended into a smooth backward and forward motion at point of separation of parts from chips. Quickly converted for chip grading by turning a cam which raises the lower end of the carriage off its rollers and creates uniform oscillation throughout the carriage. Various screen sizes available. Area occupied by machine, 3 by 6 ft; with pans, 3 by 8 ft. *The Gravi-Flo Corp., Sturgis, Mich.*

Portable Air Compressor: Model B-100 piston type, lightweight, automatic pressure regulated unit. Has 12-gal stainless steel air receiver; V-belt driven ½-hp, 115/230-v, single-phase, 1725 rpm, heavy-duty, ball bearing capacitor motor. Displacement at 100 lb pressure, approximately 2½ cfm. Stationary Model A-100 also available. *National Tool & Equipment Co., Chicago, Ill.*

Surface - Resistance Indicator: Designed to help produce a better resistance welding bond by providing rapid and accurate measurement of the resistance between pieces of metal to be welded. Comprised of two parts—a microhmmeter and a sample holder. Sample holder consists of hydraulic ram which has a pair of current electrodes, emf electrodes, and a pressure gage. Emf electrodes are so spaced as to make the measurement independent of sample size. Sample pieces of metal to be welded are placed between jaws of sample holder and subjected to desired pressure. Surface resistance between metal samples is indicated

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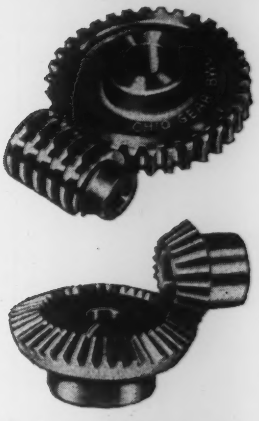

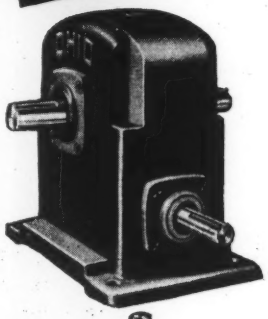

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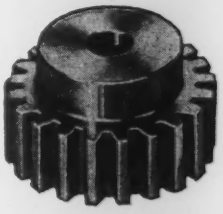

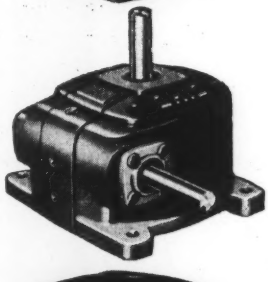

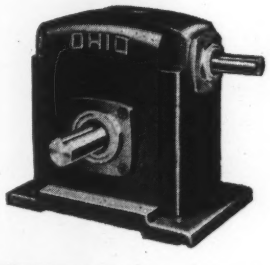

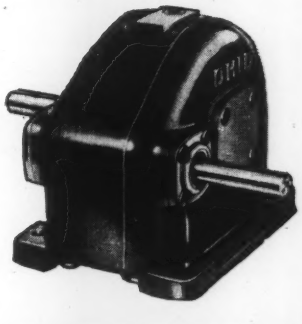

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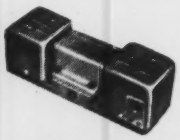
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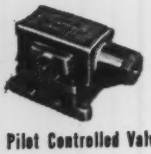
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on microhmmeter, which is connected electrically to sample holder. Has two ranges: 0-200 and 0-2000 microhms. Measured resistance is indicated directly in microhms on a linear 100 division scale. *General Electric Co., Schenectady, N. Y.*

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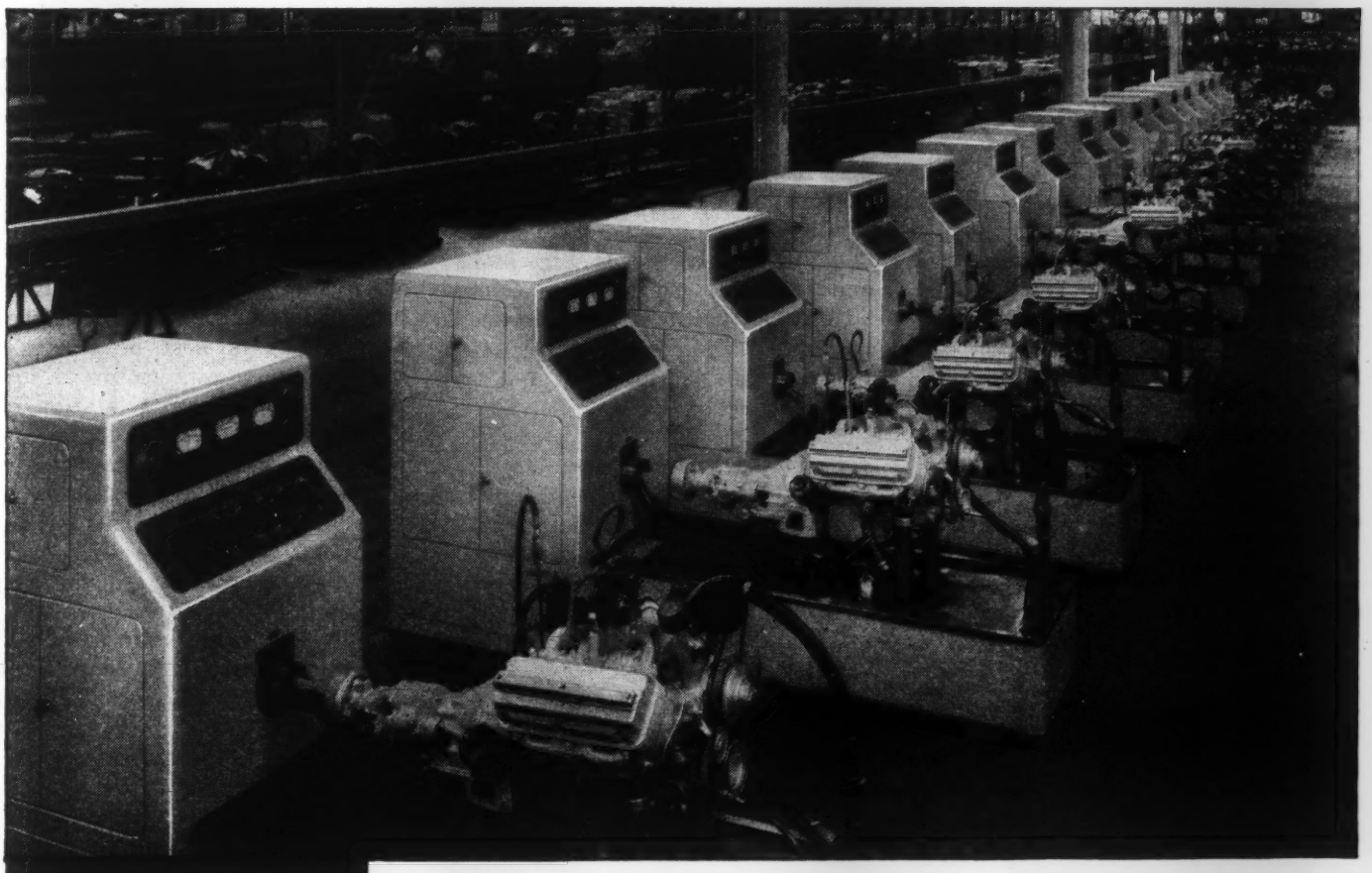
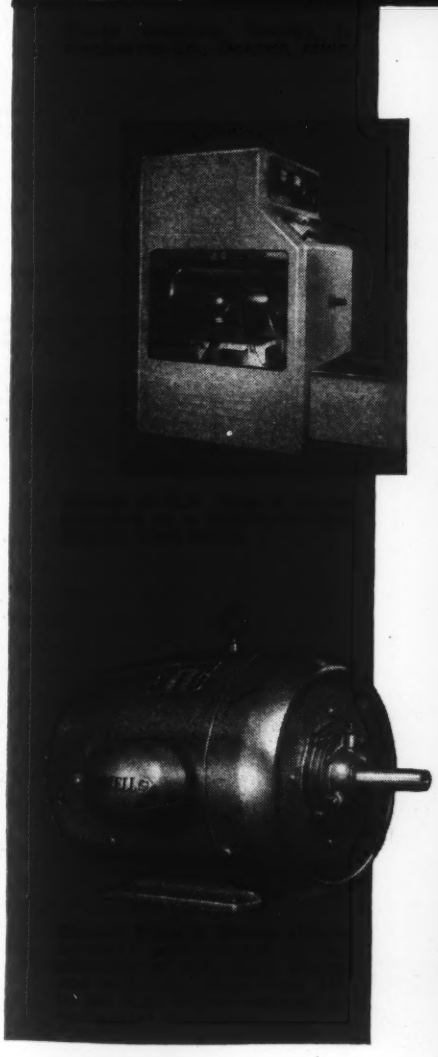
Parts Finishing System: Completely finishes 1440 small parts per hour. Washes, phosphatizes, rinses, and dries parts, then dip-paints, drains and bakes them, returning them to loading station for unloading by operator. Occupies 20-ft square of floor space; is 10 ft high. Parts are placed on racks attached to machine's overhead conveyor. Loaded racks pass through washing section where they are washed, phosphate coated and rinsed. After making 180-degree turn, the conveyor carries them through glassless infra-red drying oven. Dried parts then make another 180-degree turn and are lowered into paint dip tank. Rack is tilted slightly as parts pass through paint tank to eliminate air bubbles on inside of parts. Rack emerges from tank, drains for predetermined time and enters paint drying oven which is another glassless infra-red unit mounted on top of the machine. After drying is complete, racks return to operator for unloading. *The Cincinnati Cleaning and Finishing Machinery Co., Cincinnati, O.*

Portable Electric Furnace; Designed to fulfill needs of the aircraft industry for heating special aluminum bars to approximately 300 F prior to forming operations. Equipped with blower to recirculate heated air. Semiclosed opening for feeding and discharging the long bars is provided by means of an asbestos strip curtain. Heating elements are fin type strip heaters. Power requirements are 36 kw, 440 v, three-phase ac. Oven size: 3 ft wide, 6 ft long, 8 in. high. Overall size of unit: 74 in. high, 72 in. wide, 36 in. deep. *Pereny Equipment Co., Columbus, O.*

Testing and Inspection

Spring Tester: Precision instrument for checking loads and deflections of compression and exten-





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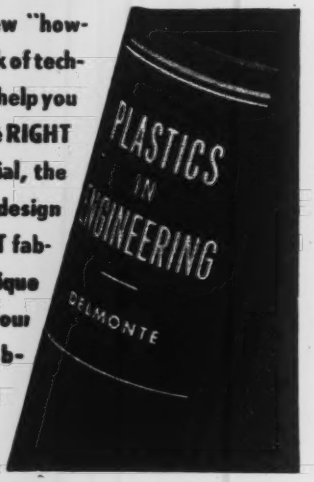

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sion springs. Capacity: loads up to 300 lb, spring diameters up to 4 in., spring lengths up to 12 in. for compression and 10 in. for extension. Used for both general purpose testing and high quantity production testing. Speed of production testing ranges from 300 to 600 tests per hour. Production stops and tolerance markers are easily adjustable; accuracy is guaranteed within 0.025 per cent. Size: 14½ by 5 in. base; 38 in. high; dial, 15 in. OD. *The Carlson Co., New York, N. Y.*

Creep Testing Machine: Capacity, 12,000 lb. Developed by research laboratory of Heppenstall Co. primarily for increased convenience of use and reliability of operation in creep-rupture tests: may also be used for regular creep testing. Features power-operated lifting mechanism for weights used for loading specimens. During testing, lifting platform automatically positions itself about ½ in. below weight pan so that shock of dropping weights is minimized when specimen breaks in stress-rupture tests. Large furnace with three heating zones is provided for testing at temperatures up to 1800 F. Temperatures in three zones can be regulated individually from control panel. Occupies floor space 43 by 20 in.; is 84 in. high; weighs 1000 lb. *Arcweld Mfg. Co., Pittsburgh, Pa.*

Woodworking

Electric Saws: Feature Kickproof clutch for safety. When blade binds in kerf or strikes a knot, clutch allows motor to turn while blade remains stationary. Equipped with depth adjustment which can be set accurately in a few seconds. Moves vertically on dovetail ways which are precision machined to maintain uniformity of cut depth. Designed for easy one-hand operation. Model 507, with 7½-in. blade, cuts from 0 to 2½ in. maximum at 90 degrees and from 0 to 1 27/32 in. at 45 degrees. Overall size, 11¾ by 8⅛ by 10½ in.; weighs 15 lb. Model 508, with 8-in. blade cuts from 0 to 2¾ in. at 90 degrees and from 1/32 to 2 in. at 45 degrees. Overall size, 12 by 8⅜ by 11½ in.; weighs 17 lb. *The Porter-Cable Machine Co., Syracuse, N. Y.*

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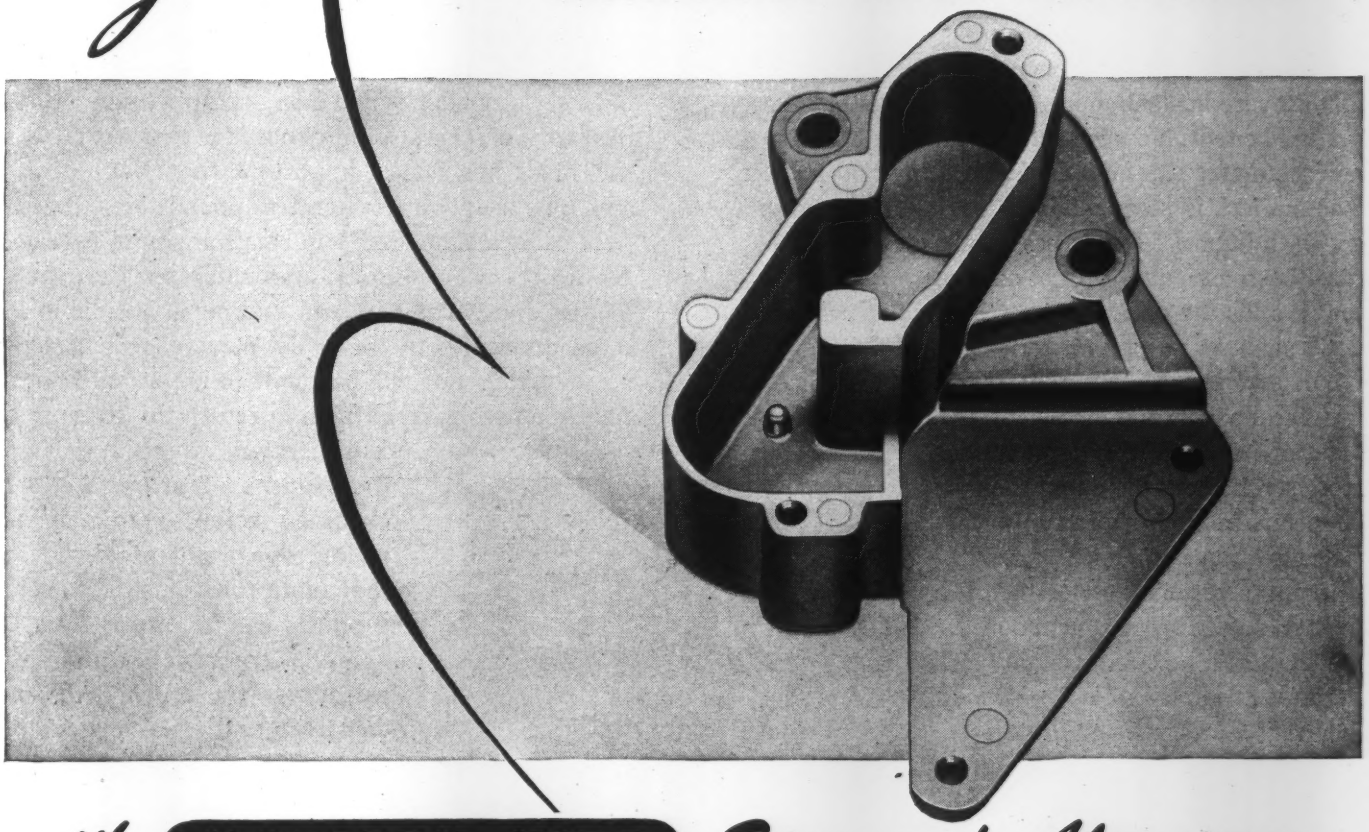

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BUSINESS IN MOTION

To our Colleagues in American Business . . .

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Scrap comes from many different sources, and in varying amounts. A company making screw-machine products may find that the finished parts weigh only about 50% as much as the original bar or rod. The turnings are valuable, and should be sold back to the mill. Firms who stamp parts out of strip have been materially helped in many cases by the Revere Technical Advisory Service, which delights in working out specifications as to dimensions in order to minimize the weight of trimmings; nevertheless, such manufacturing operations inevitably produce scrap. Revere needs it. Only by obtaining scrap can Revere, along with the other companies in the copper and brass business, do the utmost possible in filling orders. You see, scrap helps us help you.

In seeking copper and brass scrap we cannot appeal to the general public, nor, for that matter, to the small businesses, important though they are, which have only a few hundred pounds or so to dispose of at a time. Scrap in small amounts is taken by dealers, who perform a valuable service in collecting and sorting it, and making it available in large quantities to the mills. Revere, which ships large tonnages of mill products to important manufacturers, seeks from them in return the scrap that is generated, which runs into big figures of segregated or classified scrap, ready to be melted down and processed so that more tons of finished mill products can be provided.

So Revere, in your own interest, urges you to give some extra thought to the matter of scrap. The more you can help us in this respect, the more we can help you. When a Revere salesman calls and inquires about scrap, may we ask you to give him your cooperation? In fact, we would like to say that it would be in your own interest to give special thought at this time to all kinds of scrap. No matter what materials you buy, the chances are that some portions of them, whether trimmings or rejects, do not find their way into your finished products. Let's all see that everything that can be re-used or re-processed is turned back quickly into the appropriate channels and thus returned to our national sources of supply, for the protection of us all.

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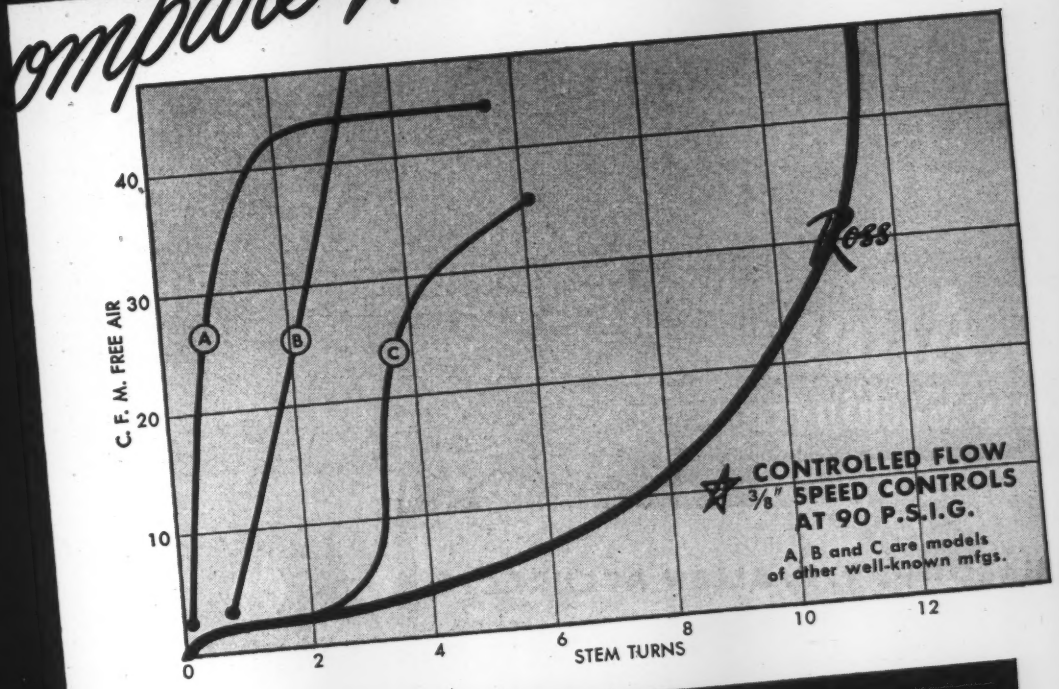

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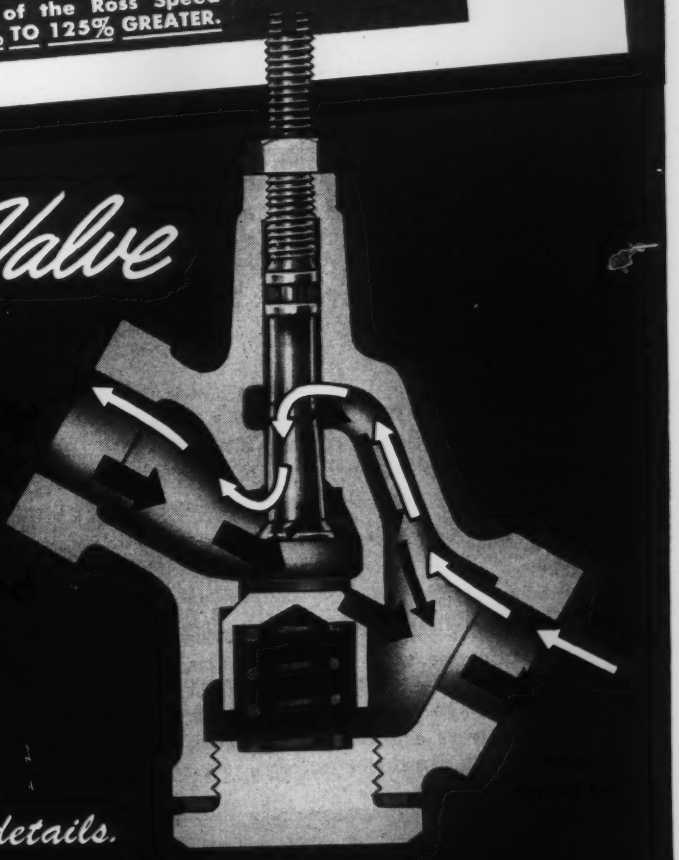

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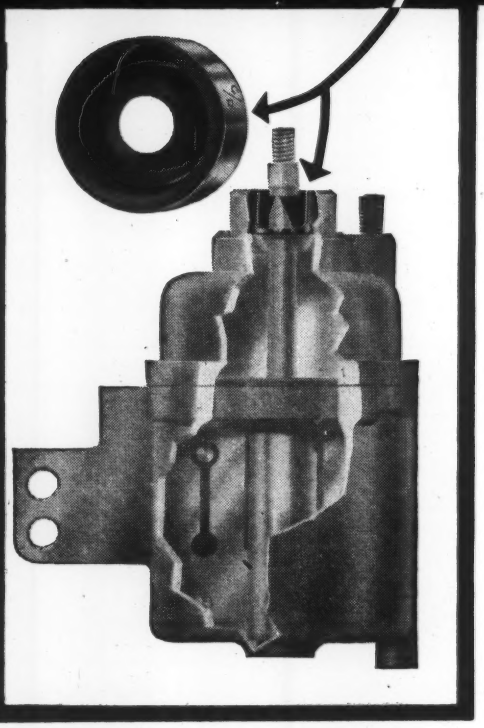

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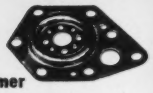

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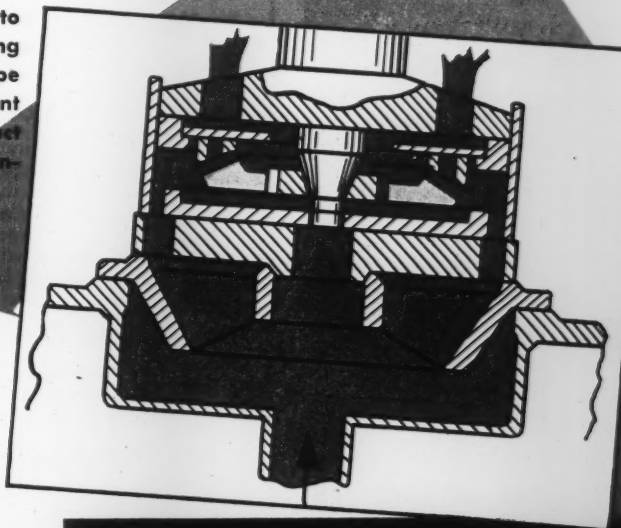
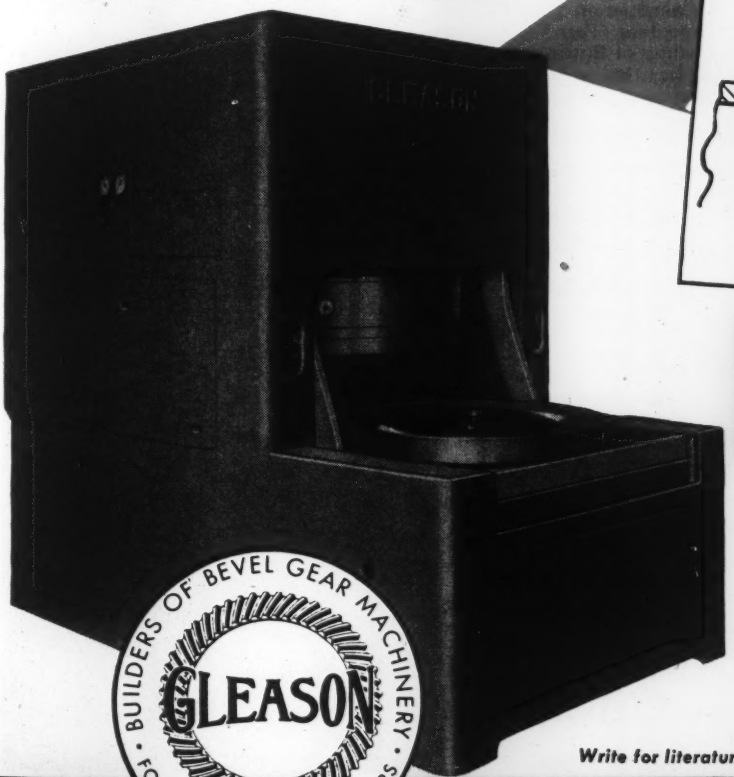
When hardening of metal parts is required, the first thought is to prevent distortion. Gleason quenching presses hold parts being quenched between dies which maintain the original shape throughout a metallurgically correct oil flow. This die equipment conforms to the actual shape of the part, and does not obstruct free oil flow over and around the part. It maintains true concentric shape of the part during the entire quench.



Timing cycle begins and quenching oil is forced into quenching chamber and around gear. Quantity and time cycle are under positive control during complete quenching cycle.



In the Gleason No. 36 Quenching Press parts up to 36" may be hardened. Among the many advantages which the 36" Press provides are:

- **Controlled quenching at faster and safer production**
- **Simplified set-ups**
- **Metallurgically correct oil flow**
- **Safer loading**
- **Quenching without distortion**

Write for literature. Send in prints of parts to be quenched for our recommendations.

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AP	Application Procedure (Part V)
LF	Full Scale Drawings of Bearings
H	Tables, formulae, bearing principles, load computation, bearing installation
	MAINTENANCE AND SERVICE
SP	Service Procedure for Ball Bearings
R	Interchangeable Replacement Bearings
FW	Front Wheel Adjustment Chart
	GENERAL
S	Standard Catalog (Handbook, Vol. I)
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D	Sealed bearings (Discussion of Principles)
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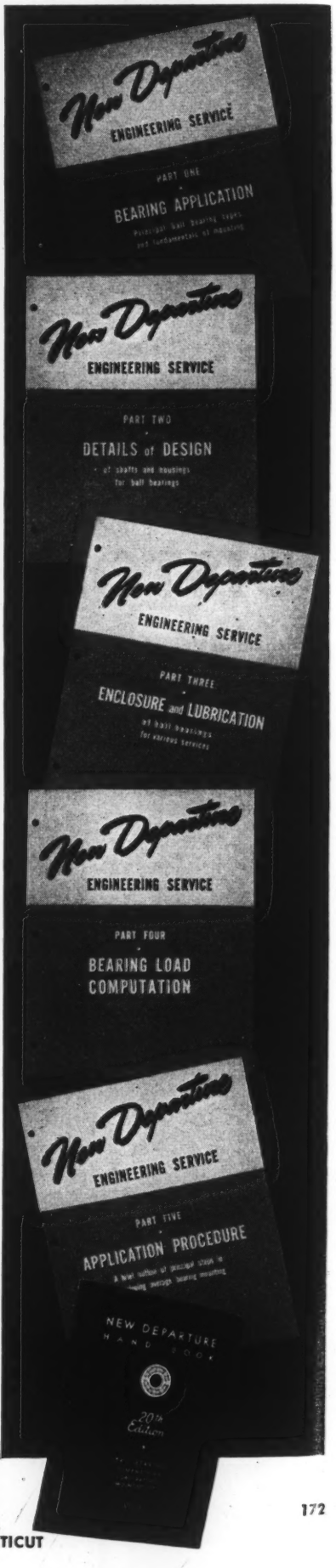

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MACHINE DESIGN is indexed in Industrial Arts and Engineering Index Service, both available in libraries generally.

This Super Stainless Gives You New Freedom From Corrosion!

When you're faced with a severe corrosion problem, investigate the super corrosion resistance of Carpenter Stainless No. 20. This sulphuric acid resisting Stainless can often reduce shutdown time and add substantially to equipment life.

If you are familiar with this alloy in its cast form, known as Durimet 20*, you can appreciate Carpenter No. 20's superior resistance to sulphuric acids, plating and pickling solutions, mixed acids, etc. Now that Carpenter has solved the problem of producing this Stainless in rolled forms such as bars, wire, strip and tubing, the alloy is enabling industry to add months—even years to equipment life.

Of course, because of No. 20's high nickel content, there isn't always enough to "go around". Yet many engineers tell us they're planning now to use No. 20 as soon as possible to improve corrosion resistance in their products and reduce shutdowns. For help in your product planning work get the new Carpenter Stainless No. 20 Book. In addition, start now to discover for yourself the far-reaching advantages of No. 20. We'll be glad to provide test coupons and work with your engineering staff.

Imagine What Corrosion Resistance Like This Can Mean To You!

The problem here was to find a material that would stand up in nozzles used to fill storage batteries with electrolyte. Special fixtures were used to handle 12% sulphuric acid (specific gravity 1.080) at temperatures from 70°F to 130°F. Hard rubber nozzles broke frequently—and shutdowns for replacement often ran as high as 30 minutes. Even 18-8 Stainless nozzles, while solving the breakage problem, corroded so badly they lasted only *2 weeks* (see 18-8 nozzle on right of photo). Then Carpenter No. 20 was put to work. After they had been in use for *many months*, nozzles made from No. 20 showed no signs of corrosion (see No. 20 nozzle on left of photo).

*Carpenter Stainless No. 20 is licensed under The Duriron Company, Inc., U.S. Pats. 2,134,670; 2,185,987 and 2,200,208.

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more than corrosion resistance

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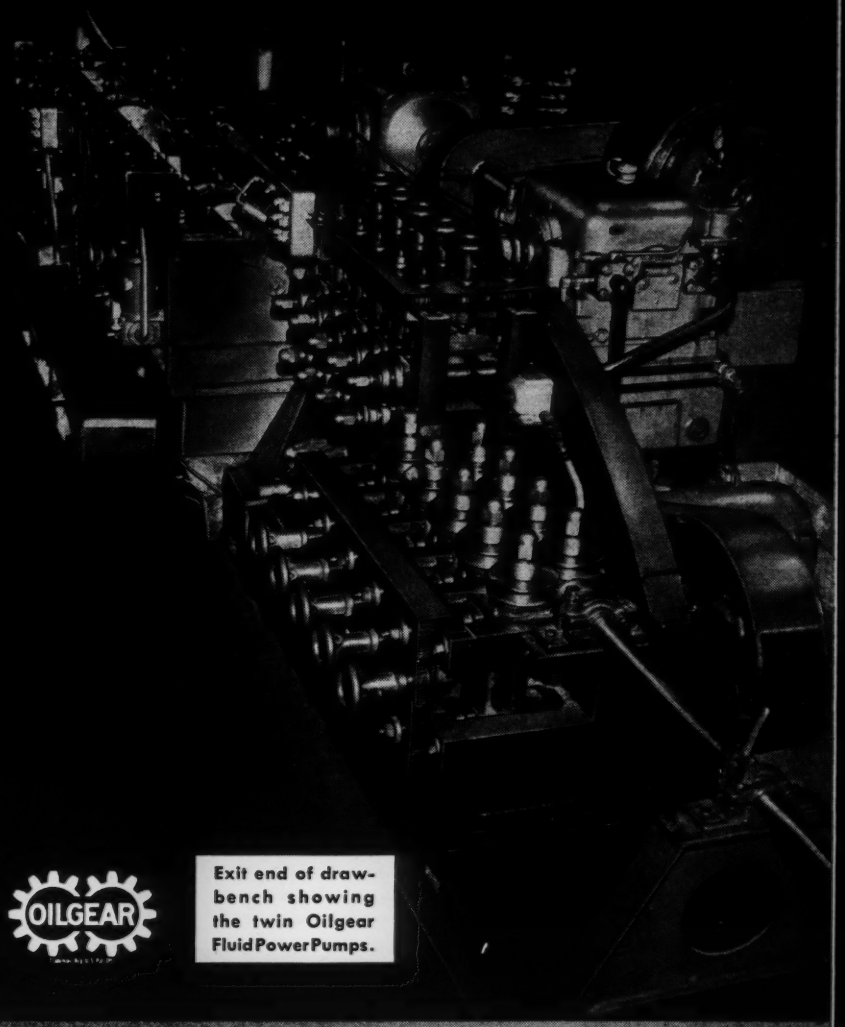
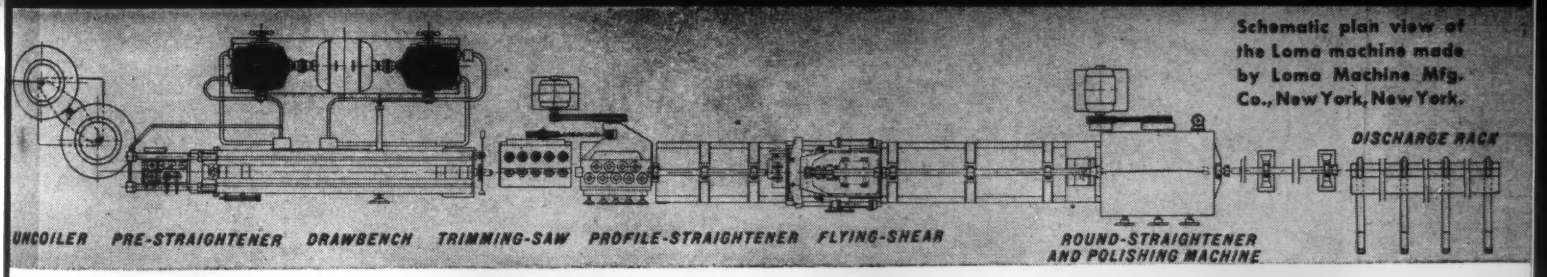
EMPLOYS

OILGEAR

AT CRUCIAL POINTS



Exit end of drawbench showing the twin Oilgear Fluid Power Pumps.



Schematic plan view of the Loma machine made by Loma Machine Mfg. Co., New York, New York.

AN unusual type of rod-processing machine produces finished stock at a rate two to three times faster than on conventional drawbenches or other types of continuous drawbenches. Drawing, straightening, shearing and polishing of brass rod are done in one operation on these Oilgear-equipped Lomatic machines.

Oilgear variable delivery pumps, cylinders and valves operate feed roll clamp to start rod through the pre-straightener. The Oilgear equipment provides synchronized operation in tandem and high-speed alternate drop-back in the draw carriage cycle. These functions are crucial to the successful operation of the Lomatic. The wonderfully smooth and steady drawing speed gained from Oilgear equipment means the production of uniformly high quality stock. The operator has full manual control of his machine for set-up and test purposes. He has remote pushbutton control of each carriage . . . and full automatic continuous operation. These superiorities result from the Oilgear simplified fluid power and control system.

Here is another outstanding achievement in machine design where Oilgear Fluid Power plays an important role in enabling the designer and builder to gain the requisite flexibility of application and control of power, simplicity of construction, engineering and installation, sturdiness, and built-in protection against overload.

You can do things with *this* power you *CAN'T* do with any other power . . . and you can do them *BETTER* with Oilgear Fluid Power equipment. What is your problem? Write THE OILGEAR COMPANY, 1568 W. Pierce Street, Milwaukee 4, Wisconsin.

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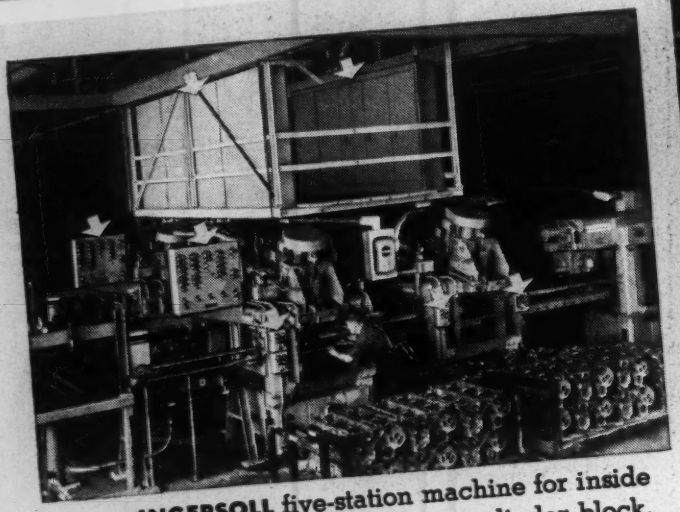


INGERSOLL five-station machine for inside reaming, boring and milling on cylinder block. 16 different operations.

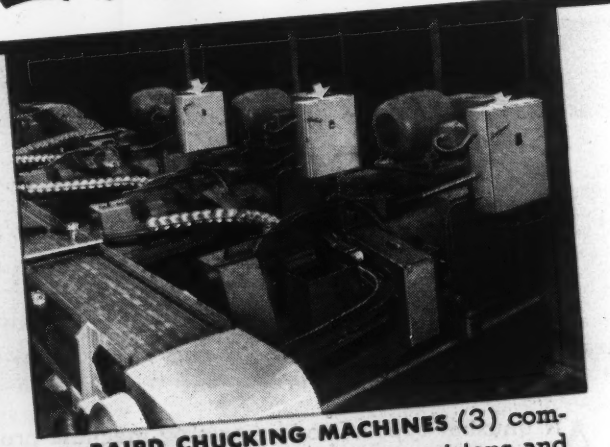
CROSS TRANSFER-MATIC twelve-station machine does boring, drilling, tapping, reaming and chamfering on flywheel housing.

AUTOMATION ENGINEERS

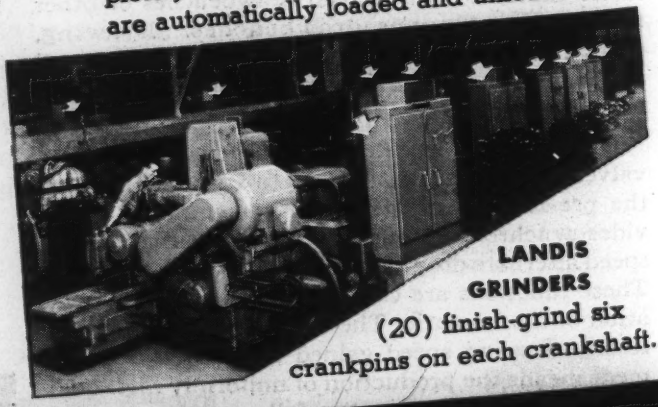
FORD

This new Ford Motor Company, Cleveland engine plant is an outstanding example of America's most recent mass production advance—***automation.***

• Square D motor control was specified for the many individual machines which make this entire plant virtually automatic.

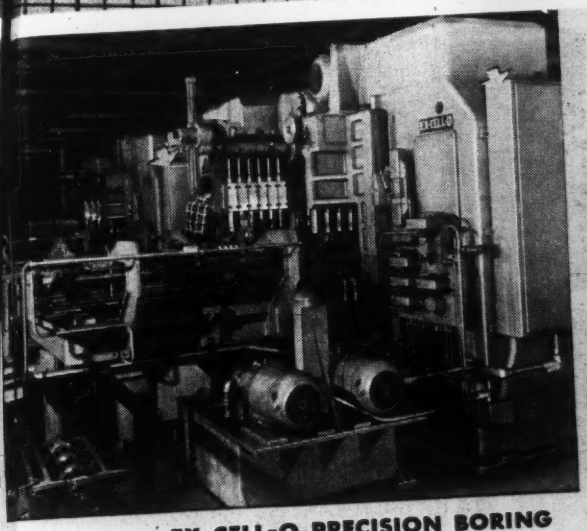


BAIRD CHUCKING MACHINES (3) completely finish-turn automotive pistons and are automatically loaded and unloaded.



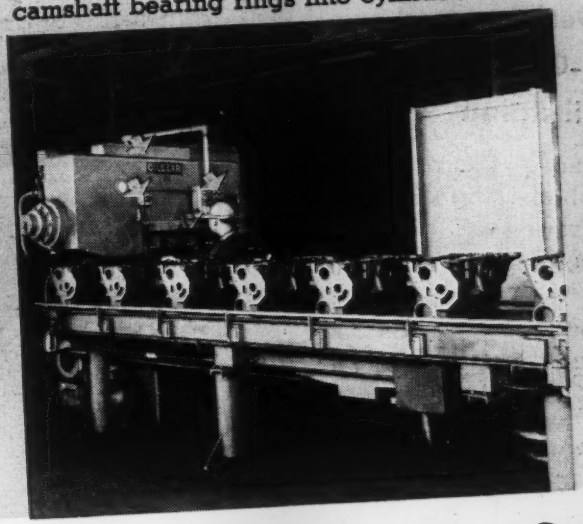
LANDIS GRINDERS (20) finish-grind six crankpins on each crankshaft.

SQUARE D COMPANY



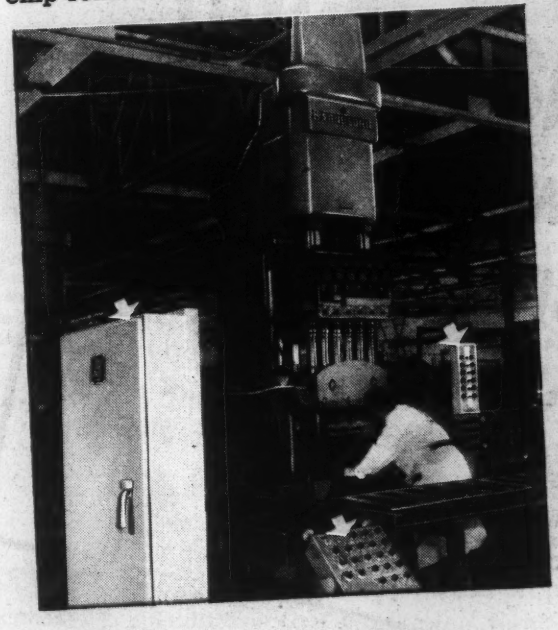
EX-CELL-O PRECISION BORING MACHINE for finish-boring on all cylinder holes, simultaneously.

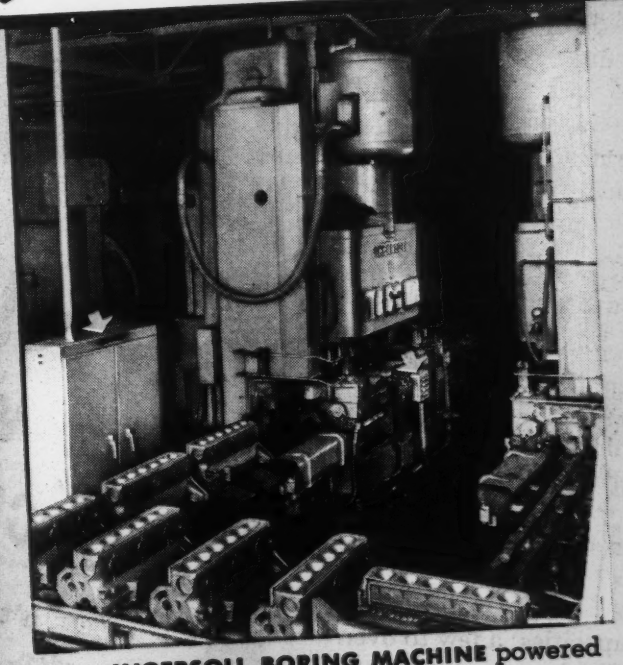
OILGEAR HYDRAULIC PRESS inserts four camshaft bearing rings into cylinder block.



SPECIFY SQUARE D!

BARNESDRIL hones all cylinder walls at one time. Feeding, honing, ejection and chip removal are all completely automatic.





INGERSOLL BORING MACHINE powered by 100 HP motor, automatically rough-bores all cylinder holes in two settings.

FIELD ENGINEERING SERVICE THROUGH SQUARE D OFFICES
IN 50 PRINCIPAL U. S. AND CANADIAN CITIES

Build This into Your Designs: Low-Cost Fluid Filtration

For a wide range of micronic filtration problems, the Cuno MICRO-KLEAN is the *lowest-cost* device you can specify, for the *efficiency* you desire.

It's *low-cost* because it's so simple. Just a single cartridge of "felted" fibres. Easy to install, easy to replace. And it *lasts* twice as long as other cartridges, because it has twice the dirt capacity, due to maximum porosity (85-90%) and exclusive "graded density in depth".

It's *efficient* because it works by a positive mechanical principle—the only micronic filter to do so. Thousands of tiny fibres are carefully distributed throughout the structure to form interstices in which the solids are trapped.

The cartridge gets its strength from resinous impregnation and polymerization.

Saves Space, Too!

Cuno MICRO-KLEAN is *all* filter —no structural components. This means less space needed—makes full flow filtration practical for either external or built-in applications.

GUARANTEED to remove 100% of all solids for which it is rated* plus a large percentage down to 1 micron. Capacities: a few to over 800 gpm. Single or multiple-cartridge units.

*15, 25, 50 microns.

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Dept. 202D, South Vine Street, Meriden, Conn.
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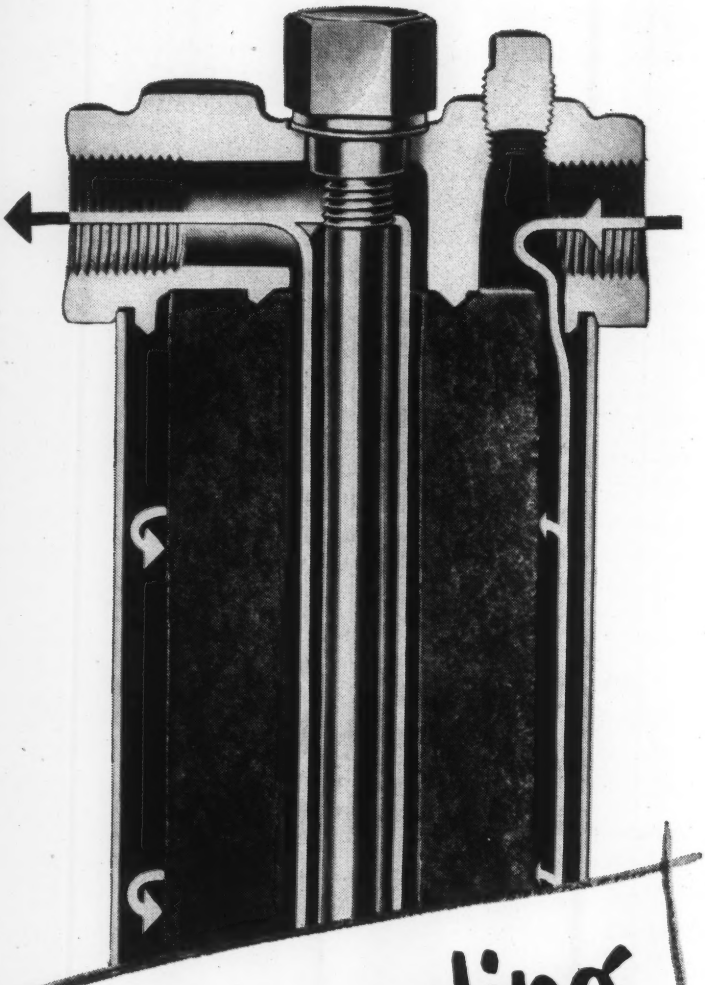

No Channeling with this micronic filter

Won't shrink, won't swell. Won't harden, won't soften. Won't distort in any way. That's Cuno MICRO-KLEAN . . . the filter that outlasts any other replaceable-cartridge filter 2 to 1!

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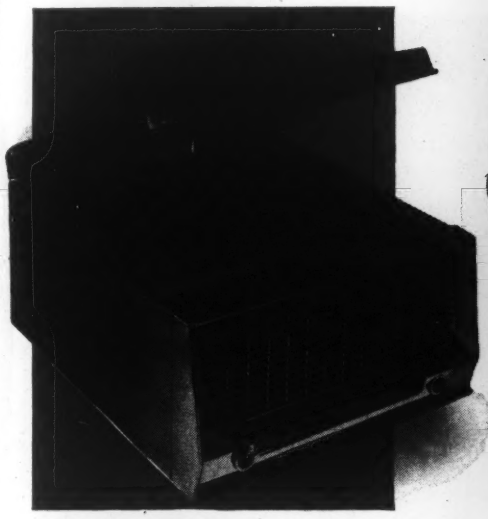
Removes More Sizes of Solids from More Kinds of Fluids

Strain fuels, lubricants, process fluids, etc.—AUTO-KLEAN
Filter fuels, lubricants, process fluids, etc.—MICRO-KLEAN
Clean raw water, recirculating water, etc.—FLO-KLEAN



Beauty of mahogany mottle finish, fine details, scratch-resistance, light weight and strength at reasonable cost feature this cabinet for Philco radio-phono combination. It's **BAKELITE BM-780 General-Purpose Phenolic.**

Molded by The General Industries Co., Elyria, Ohio, and American Insulator Corp., New Freedom, Pa.

Strength and stability! This impeller for Sears, Roebuck's Kenmore Dishwasher is made of **BAKELITE Water-Resistant, Improved-Impact Phenolic BM-13080.** It stands up under whirling, scalding water, blasts of hot air, attack by soap and detergents.

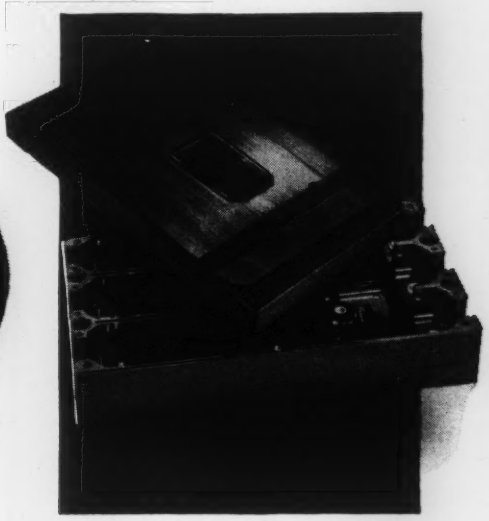
Molded by Martindell Molding Co., Trenton, N. J.

Service for six years without failure on New York's subways—despite weather extremes, moisture, vibration 20 hours a day! It's a subway shoe contact fuse housing that has been molded from **BAKELITE Medium Impact-Resistant Phenolic BM-1132.**

Made for The Horne Products Co. by Boonton Molding Co., Boonton, N. J.

High resistivity, low-loss factor, and dimensional stability are all built into these bases for diheptal tubes in television sets. They're **BAKELITE Natural "Low-Loss" Insulation Phenolic BM-16981.**

Made for Sylvania Electric Products Inc. New York, N. Y.



Intricate design and electrical resistivity—up to 600 volts AC, 250 volts DC, 10-600 amps.—are two of many features of this I-T-E Circuit Breaker case molded of black **BAKELITE General-Purpose Phenolic BM-2498.**

Made for I-T-E Circuit Breaker Co., Philadelphia, Pa., by American Insulator Corp., New Freedom, Pa.

Heat resistance, good electrical properties combine in this magneto distributor plate for heavy-duty automotive equipment. It's **BAKELITE BM-18425 General-Purpose Phenolic** with improved electrical insulation qualities.

Made for American Bosch Corp. by Specialty Insulation Mfg. Co., Hoosick Falls, New York.

Why Phenolic Plastics get the job!

The wide variety of BAKELITE Phenolic Plastics means that you can pick the *right* combination of properties to suit your particular purpose.

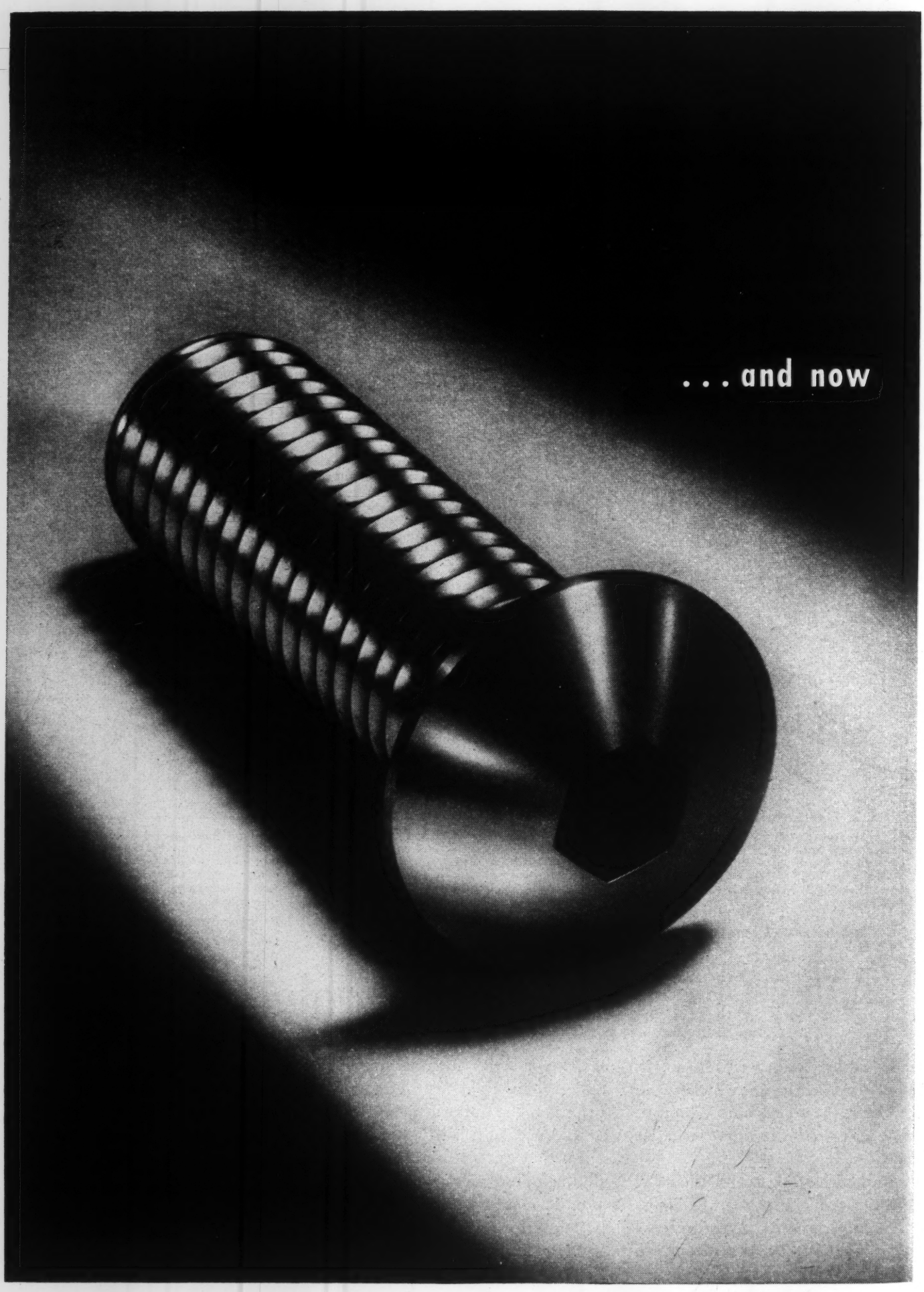
And with *all* BAKELITE Phenolic Plastics, you'll get the plus-factors of strength, beauty, economy, ease of production. Their resistance to chemicals and moisture, good electrical properties, long service life, and light weight are added features you can't afford to overlook.

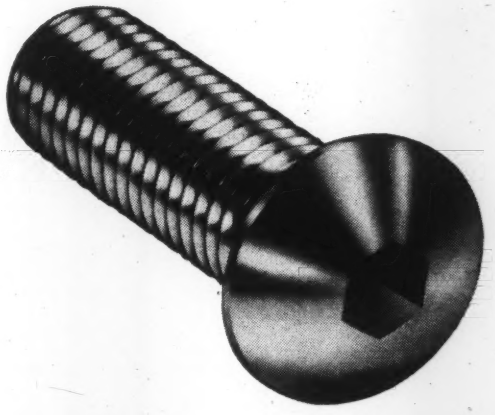
Select the phenolic molding material that's best for your application...put it to work for your product. It means improved design, better performance, more saleability! Our Engineers will be glad to help you. Write Dept. DW-52.

BAKELITE
TRADE-MARK
PHENOLIC PLASTICS

TRADE MARK

BAKELITE COMPANY
A Division of
Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.
In Canada:
Bakelite Company (Canada) Ltd., Belleville, Ont.


. . . and now



UNBRAKO BUTTON HEAD SOCKET CAP SCREWS

These UNBRAKO screws are strong, accurate and uniform. They are designed for applications where countersinking is not practicable. They feature:

- **Head and threads concentric with the body**
- **Threads to head**
- **Low head height that streamlines design**
- **Nonslip drive that speeds assembly**
- **Nonburr socket that eliminates injuries from sharp splinters**
- **Class 3 fit—an UNBRAKO standard**
- **Stocks at your UNBRAKO industrial distributor**
- **Standard sizes—#8 through ⅝" diameter**

Write for literature. STANDARD PRESSED STEEL CO., Jenkintown 18, Pennsylvania.

UNBRAKO® SOCKET SCREW DIVISION

SPS

JENKINTOWN PENNSYLVANIA

WHAT *Life-Lines* REALLY DELIVER IS MORE SERVICE...LESS SERVICING

See the space you save with these modern Life-Lines

Both Life-Line motor and Life-Linestarter are space stretchers. The reason? Compactness. They are smaller, lighter than most conventional types . . . can be installed in close quarters where others can't be accommodated.

Notice that the motor has no grease cups or fittings. It's pre-lubricated . . . needs no further lubrication. This means you can cramp it into close quarters, forget greasing channels and nipples brought to outside of machine. Just install it in "hard-to-get-at" locations and forget it! The way to grease a modern motor is *don't.*

A check of the Life-Linestarter will show you all parts can be removed straight from the front. No need to allow extra work room for servicing. Further, wiring is straight through. You get simplified wiring, shorter leads. And you can have two electrical interlocks without increasing starter width. This means, smaller cavities and more compact cabinets.

These features give you the most advanced designed equipment available today. Built to match the modern advancements you build into your equipment. But get complete data. Ask your Westinghouse representative for latest information, or write Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21692

YOU CAN BE SURE...IF IT'S

Westinghouse

Life-Line

MOTORS and CONTROLS

PERFECTLY MATED! Only Phillips Drivers are perfectly mated to Phillips Screws. Look for the name Phillips on the shank.

Q. *How can they increase your sales?*

AMERICAN SCREW CO. • ATLANTIC SCREW WORKS, INC.
THE BLAKE & JOHNSON CO. • CAMCAR SCREW & MFG. CORP.
CENTRAL SCREW CO. • CONTINENTAL SCREW CO. • THE EAGLE LOCK CO.
ELCO TOOL AND SCREW CORP. • GREAT LAKES SCREW CORP.
THE H. M. HARPER CO. • THE LAMSON & SESSIONS CO.
NATIONAL LOCK CO. • THE NATIONAL SCREW & MFG. CO.
PARKER-KALON CORP. • PHEOLL MFG. CO.
ROCKFORD SCREW PRODUCTS CO. • SCOVILL MFG. CO.
SHAKEPROOF INC. • SOUTHERN SCREW COMPANY
THE SOUTHINGTON HDWE. MFG. CO. • STERLING BOLT CO.
STRONGHOLD SCREW PRODUCTS, INC. • WALES-BEECH CORP.

A. ***Through the Phillips Cross-Recessed-Head Screws that they manufacture.*** These famous fasteners are a mark of quality manufacture to your customers. Phillips Screws are nationally advertised in The SATURDAY EVENING POST as the clue to quality: X marks the spot. You'll find them a real sales-plus on your product. What's more, you save time, work, money with Phillips Wood, Machine, Tapping Screws or "Sems." They cut driving time up to 50%, set up tighter, add structural strength. With Phillips Screws you'll find production power driving practical, cut lost time due to accidents. Be sure to cash in on their many benefits.

X marks the spot... the mark of extra quality

PHILLIPS *Cross-Recessed-Head* SCREWS

As Advertised in The Saturday Evening POST

THE FASTENERS OF TODAY . . . AND OF THE FUTURE

NEW! HANNIFIN PRECISION BUILT "Space Saver" HYDRAULIC CYLINDERS

SPECIALLY DESIGNED FOR MACHINE TOOL BUILDERS

When you mount a hydraulic cylinder in a *machine tool*, it *ought* to be good. It *should* be precision engineered . . . quality constructed for long, trouble-free service.

Now, Hannifin offers that kind of hydraulic cylinder in its two compact "Space Saver" lines. Designed by Hannifin Engineers, these cylinders make no compromise with good design—are built to the exacting standards that have made Hannifin Series N cylinders the standard of the industry.

Whether you need these rugged, all-steel hydraulic cylinders for production tools or for machines you build for resale, investigate these new Hannifin designs today!

NEW HANNIFIN TYPE SS "SPACE SAVERS"

9 Bore Sizes, 1½" to 6"—Pressures to 2000 P.S.I.

WHY HANNIFIN "SPACE SAVERS" ARE BEST FOR YOUR MACHINES

Ruggedly constructed in FULL COMPLIANCE with J.I.C. Hydraulic Standards. MULTIPLE seal gland packing removable without disassembling cylinder—UNOBSTRUCTED ports—PRECISION piloting of cylinder body and end caps—pre-stressed tie rods—positive end seals—end caps machined from solid steel—hardened rods available. As in all other Hannifin designs, cylinder walls are "Tru-Bored" and honed; rods are turned, ground and polished; mounting clevises, angles and flanges are sturdy, well designed.

WRITE FOR BULLETIN 111

Contains complete construction details and specifications for all models.

NEW UNIVERSAL MODEL U

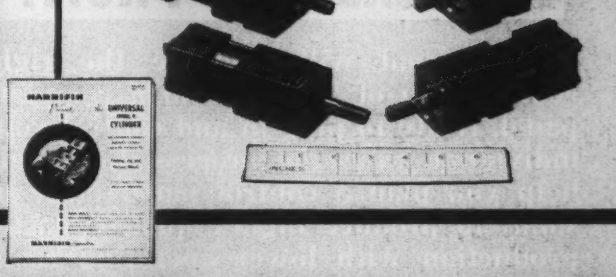
1", 1¼", 1½" Bores—Pressures to 1000 P.S.I.

IDEAL FOR TOOLING, JIG OR FIXTURE WORK

Compact! The 1" bore cylinder is only 1½" square. Basic cylinder mounts on side or either end—also furnished with mounting flanges or head end clevises. Gland packing and piston seals feature Hannifin's new, thoroughly tested "Lip-seal" packing, which makes it possible for these compact little cylinders to operate on either hydraulic oil or lubricated air. Combines low friction with minimum leakage. Hardened rods standard.

WRITE FOR BULLETIN 112

Complete description and specifications



do ALL you CAN do . . . with

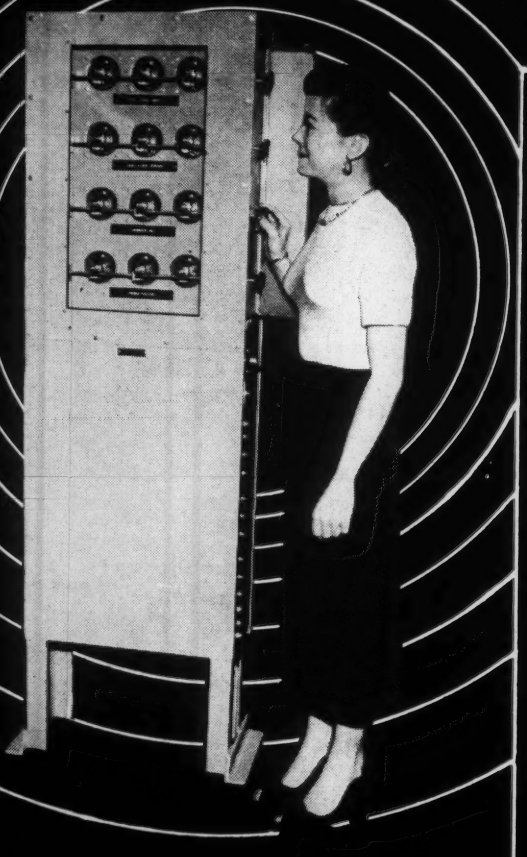
HANNIFIN

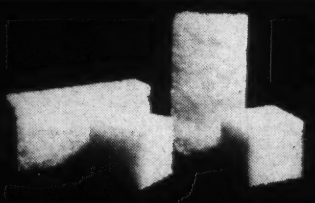
Hannifin Corporation, 1115 S. Kilbourn Ave., Chicago 24, Ill.

Air and Hydraulic Cylinders • Hydraulic Power Units • Pneumatic and Hydraulic Presses • Air Control Valves

EAGLE

CONTROL PANELS





The Eagle control panel shown, operates three sugar centrifugals, each with four time steps of acceleration, wash water on, off, and brake. The 4 Cycl-Flex timers operate independently in sequence. The time set dial in each row are geared together to one setting knob. The setting of one knob controls 3 machines simultaneously. The centrifugal valves are pneumatically controlled by solenoid, operated air valves in the base of the panel. Built complete by Eagle ready to accurately and automatically control each operation.

FOR GREATER PROFIT

Eagle Signal will assemble the right combination of Timers into a complete panel, ready to plug in and control your individual industrial process. Let Eagle help you plan a control panel large or small to produce higher quality, faster production with lower operating costs. Send your control problem to Eagle today.

EAGLE SIGNAL
Industrial Timers
EAGLE SIGNAL CORPORATION MOLINE, ILL.

AIR CYLINDERS

FOUR-WEEK DELIVERY

To Meet Your
RUSH
Cylinder Requirements

. . . now assured by our modern new plant with greatly expanded facilities—devoted exclusively to the manufacture of quality cylinders.

Write for illustrated cylinder bulletins A-105 and H-104

COMPLETE MILLER CYLINDER LINE INCLUDES: AIR CYLINDERS, 1½" to 20" BORES, 200 PSI OPERATION; LOW PRESSURE HYDRAULIC CYLINDERS, 1½" TO 6" BORES FOR 500 PSI OPERATION, 8" TO 14" BORES FOR 250 PSI; HIGH PRESSURE HYDRAULIC CYLINDERS, 1½" TO 12" BORES, 2000-3000 PSI OPERATION. ALL MOUNTING STYLES AVAILABLE.

Miller

MILLER MOTOR COMPANY

2006 N. HAWTHORNE MELROSE PARK, ILL.

AIR AND HYDRAULIC CYLINDERS · ACCUMULATORS · COUNTERBALANCE CYLINDERS · BOOSTERS · AIR HOISTS

CLEVELAND — PITTSBURGH — PHILADELPHIA — DETROIT — YOUNGSTOWN — BOSTON
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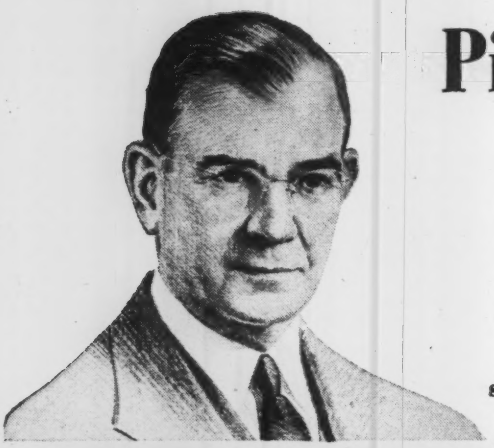
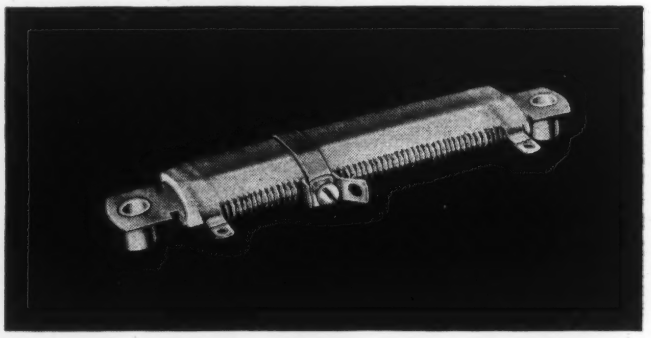
Sales and Service from coast to coast



Picker X-Ray Corporation

"For accurate duplication of X-ray densities their resistors must be stable"

says O. N. Jones, The Ambos-Jones Company, Cleveland, Ohio, representative for Ward Leonard Electric Company



Duplicating densities of precise radiographs over prolonged periods demands exacting control of milliamperage through the X-ray tube. This means filament temperature must be accurately set.

That is why the absolute balance of thermal characteristics of Ward Leonard resistors is of utmost importance to the Picker X-Ray Corporation.

The only way to be sure that all resistor components will react the same to changes in temperatures is to balance their thermal characteristics. In this way, there is no loosening, no failure, due to unbalance. Heat affects all parts the same way, which, in turn, means longer life, *stable performance.*

This stability in the presence of thermal shock is one of the major reasons the Picker X-Ray Corporation uses Ward Leonard STRIPOHM resistors in their V-12, 200 milliampere, 100 PKV X-ray controls.

The performance of VITROHM wire-wound resistors, rheostats, and other electric controls under the severest operating conditions is proof of their complete dependability.

For correct, accurate current control, specify Ward Leonard VITROHM Resistors.

WARD LEONARD

WARD LEONARD ELECTRIC COMPANY

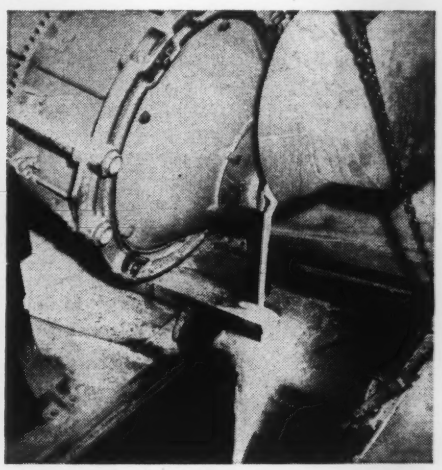
MOUNT VERNON, NEW YORK

Result-Engineered Controls Since 1892

LIMIT BRIDGE FOR TESTING resistance accuracy of Stripohm resistors is operated by Theresa Collura (foreground).

TERMINALS ARE SPOT WELDED to Stripohm cores by Frances Baxter who has been with the company 10 years.

KATHERINE GRUNENTHAL (foreground), 27 years at Ward Leonard, is winding special alloy resistance wire on Stripohm cores.



VITREOUS ENAMEL being fritted is poured white hot into a cold bath to break up the mass into small particles.

From Raw Material to Finished Product Ward Leonard VITROHM Resistor Quality Is Carefully Controlled

The dependable performance of VITROHM resistors in actual operation is the result of Ward Leonard's unified manufacture.

Design and construction are based on specialized experience. Quality is carefully guarded by Ward Leonard engineers, chemists, and technicians.

All components of VITROHM resistors are made by Ward Leonard. Vitreous enamel coating and ceramic cores are formulated in the plant, wire is drawn to Ward Leonard's specifications.

You can be sure of uniform quality by buying your resistors from the *one* manufacturer who manufactures, not just assembles, all the components that go into resistors.

Before you buy or specify resistors, be sure to call in Ward Leonard.

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Baltimore 18, Md.	Durling Electric Co.
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Hartford 6, Conn.	Ward Leonard Electric Co.
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Knoxville, Tennessee	John G. Pettyjohn
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Roanoke, Virginia	Lynn H. Morris
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St. Louis 10, Mo.	Ward Leonard Electric Co.
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San Antonio, Texas	Brance-Krachy Co., Inc.
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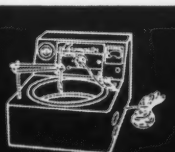
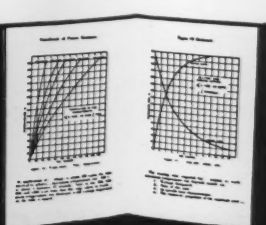
RHEOSTATS

RELAYS

MOTOR CONTROLS



CHROMASTER



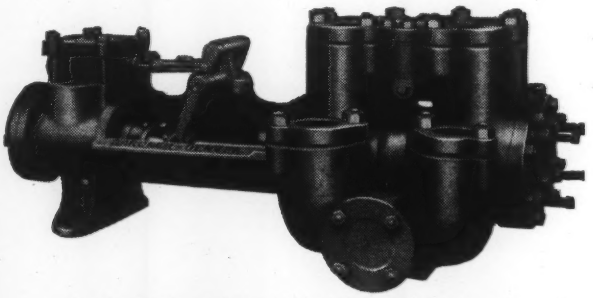
Ward Leonard's complete engineering textbook, "Handbook of Power Resistors," $3. per copy.

how to [illegible] new pump[illegible] out of the air

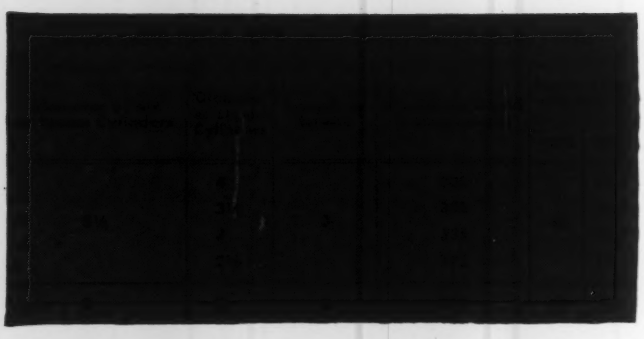
If **you are designing processing equipment or liquid transfer systems that use compressed air,**

Or *if* **— in[illegible] equipment [illegible]pressed air is [illegible] steam,**

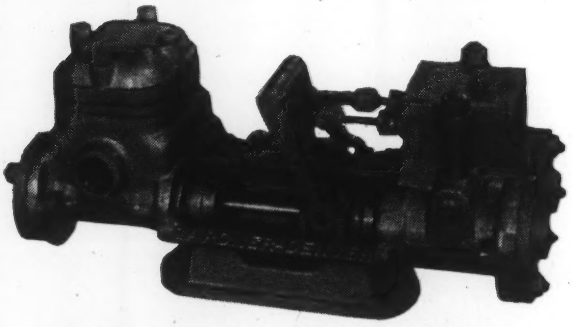
then **— consider how you can develop ingenious new pumping ideas with these Gardner-Denver Reciprocating Pumps. They operate on compressed air as well as steam.**



Gardner-Denver 5¼ x 3½ x 5 Duplex Pump with slide valves on air or steam end. One-piece cast alloy liquid end, valve pot type.



Made in other sizes, too, to meet any desired capacity or pressure. Liquid end parts may be furnished in a variety of materials for abrasive or corrosive service. For complete specifications, write us today.



Gardner-Denver 3 x 2 x 3 Duplex Pump with slide valves on air or steam end. One-piece cast alloy liquid end. Bronze, rubber or iron valves.

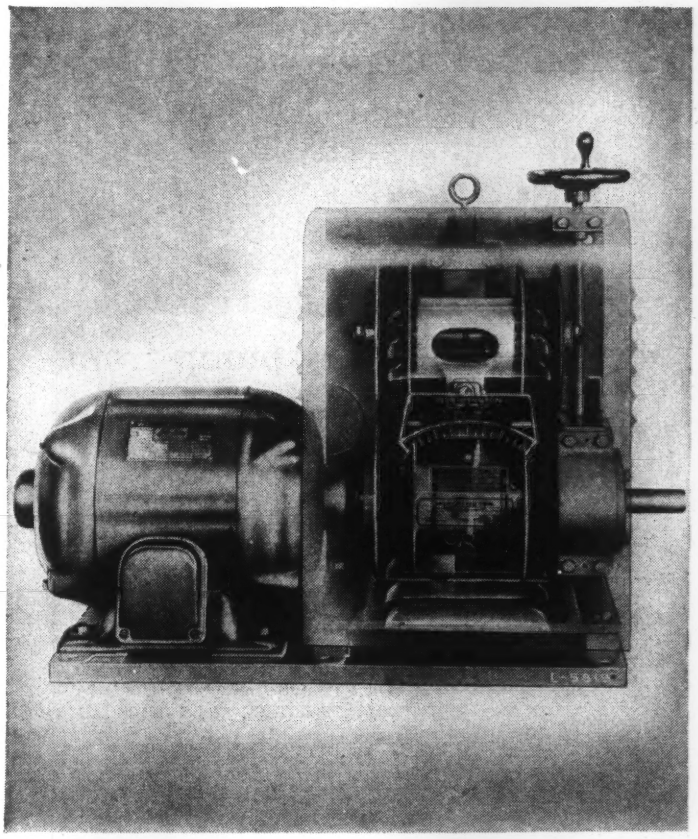
SINCE 1859

GARDNER-DENVER

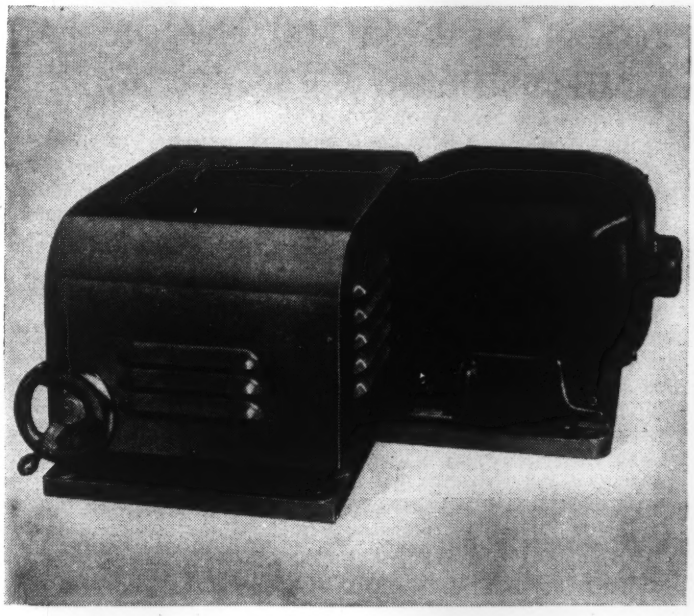
Gardner-Denver Company, Quincy, Illinois

In Canada: Gardner-Denver Company (Canada) Ltd., Toronto, Ontario

THE QUALITY LEADER IN COMPRESSORS, PUMPS AND ROCK DRILLS



PHANTOM VIEW SHOWS NARROWER BELTS OF WORTHINGTON ALLSPEED DRIVE that give smoothest operation, highest range of variation in smallest space, longest belt life.



ALLSPEED MOTOR DRIVE is available in both horizontal (shown here) or upright models. Standard NEMA frame motors are used on all sizes.

What's all this talk about 2-BELT DESIGN?

Why are two belts better than one in a variable speed drive? Don't they take more space? Isn't replacement tougher? Doesn't this mean twice the wear? How about speed ranges?

Let's take them one at a time.

First, the two-belt or tandem-belt construction of Worthington Allspeed Drive actually takes *less* space than one belt and permits a more compact design.

Second, the two belts last *longer* by far than one because they're narrower and wear less from flexing. Constant belt tensioning prevents excessive side wear and side compression, too.

Third, belt replacement, when necessary, is *easy* —no dismantling of the complete unit nor disconnecting of driver and driven shaft is required.

Fourth, you get whatever range of variation your equipment calls for. Tandem-belt design actually makes possible a *greater range* of variations and a more compact machine.

Send for Bulletin AS-1600-B6. Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Allspeed Drive Division, Holyoke, Massachusetts.

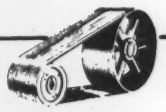
Precision lathes get stepless speed variation at no extra cost

By replacing the back gears with an Allspeed Drive, this precision lathe operated more smoothly and quietly over a greater range of spindle speeds. And at no extra cost—since the back gears were eliminated. The new lathe has *stepless* speed control and is easier to operate. The machinist merely pushes a "Fast" or "Slow" button to change spindle speeds. Space? The Allspeed unit takes less than the conventional gears and has fewer operating parts.

AS.2.1

COMPRESSORS: AIR-COOLED, WATER-COOLED

PUMPS: CENTRIFUGAL, ROTARY, STEAM, POWER



MULTI-V-DRIVES: QD SHEAVES AND V-BELTS

ALLSPEED DRIVES: WORTHINGTON ALLSPEED

Specify These Worthington Standard Products on Your Equipment

WORTHINGTON

Allspeed Drives

The motor's not just connected, it's mated to the pump

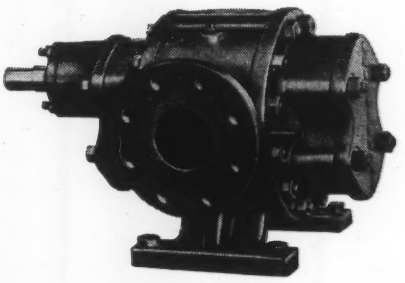
The Worthington DN monobloc centrifugal pump has pump and motor mounted on *one* shaft —perfectly "mated" for compactness and rigidity.

It's all one unit—no base plate; no extra foot supports to contend with.

The same pump—with conventional stuffing box or mechanical seal—also comes in frame mounted CN models.

Capacities 10 to 1,800 gpm.

Specify Worthington Standard Pumps



Pick your rotary pump from the line that gives you the widest choice!

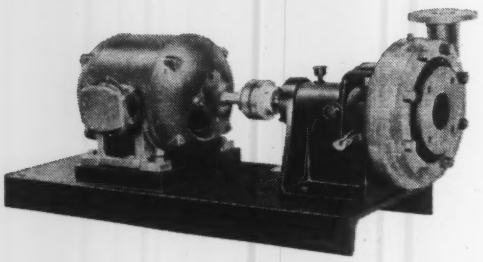
For Viscous Liquids—Smooth, Quiet Operation:

Worthington Herringbone-Gear Pumps, Types GA and GR; capacities from 1 to 5,000 gpm; pressures to 500 psi.

For Non-Lubricating, Slightly Abrasive or Corrosive Liquids:

Worthington Sliding-Vane Pumps, Types VE and VR; external or internal bearings; capacities from 25 to 1,000 gpm; pressures to 200 psi.

Specify Worthington Standard Pumps



Does a real job pumping corrosives

It's Worthington's "Worthite"—a special high alloy especially developed for pumping services.

In many environments "Worthite" is superior to ordinary stainless irons and stainless steels.

"Worthite" pumps are built in standard sizes from 1 to 5,000 gpm.

Specify Worthington Standard Pumps

The World's Broadest Line Assures You The Right Pump for Every Job

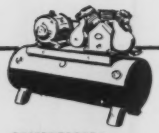
No other line is so complete . . .

Centrifugals with various mountings and capacities from 10 to 1,800 gpm; coolant and circulating types, regenerative turbine types.

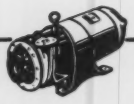
Also: gear- and vane-type rotaries from 1 to 5,000 gpm, steam pumps, power pumps, dry vacuum pumps.

Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Pump and Compressor Merchandising Division, Harrison, N. J.

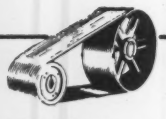
PC.2.2



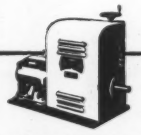
COMPRESSORS: AIR-COOLED, WATER-COOLED



PUMPS: CENTRIFUGAL, ROTARY, STEAM, POWER



MULTI-V-DRIVES: QD SHEAVES AND V-BELTS



ALLSPEED DRIVES: WORTHINGTON ALLSPEED

Specify these Worthington standard products on your equipment

WORTHINGTON

Standard Pumps

Hub Goes on FIRST

Give your machine this welcome convenience

More machinery *builders* use Worthington QD sheaves than any other hub-and-rim combination.

That's because they're the favorite of users everywhere. The QD sheave comes in two parts for easy mounting: light hub first, then heavier rim on tapered hub—or, as one-piece assembly. The split hub is easy to mount, even on over-size shaft. Large, long pull-up bolts make it easy to fasten rim—and hold better. (They can be used as jack screws for removing rim.)

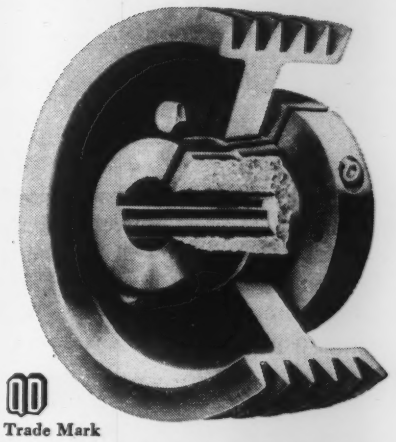
And when rims need changing, the hub *stays put*—no realignment problem to give you trouble.

The trim appearance of the QD is also a sales asset to any product.

In addition to being one of the largest-selling sheaves, the popular Worthington QD design is licensed to many other sheave manufacturers. For your customer's protection, dimensions are standardized to permit interchangeability.

For fractional horsepower, too, Worthington offers a complete line of quick-detachable V-pulleys.

Worthington Corporation, formerly Worthington Pump and Machinery Corporation, Multi-V-Drive Sales Division, Buffalo, New York.



QD Trade Mark

The original tapered cone-grip sheave. Easy to get on . . . easy to get off . . . yet always tight on the shaft.

MV.1.14

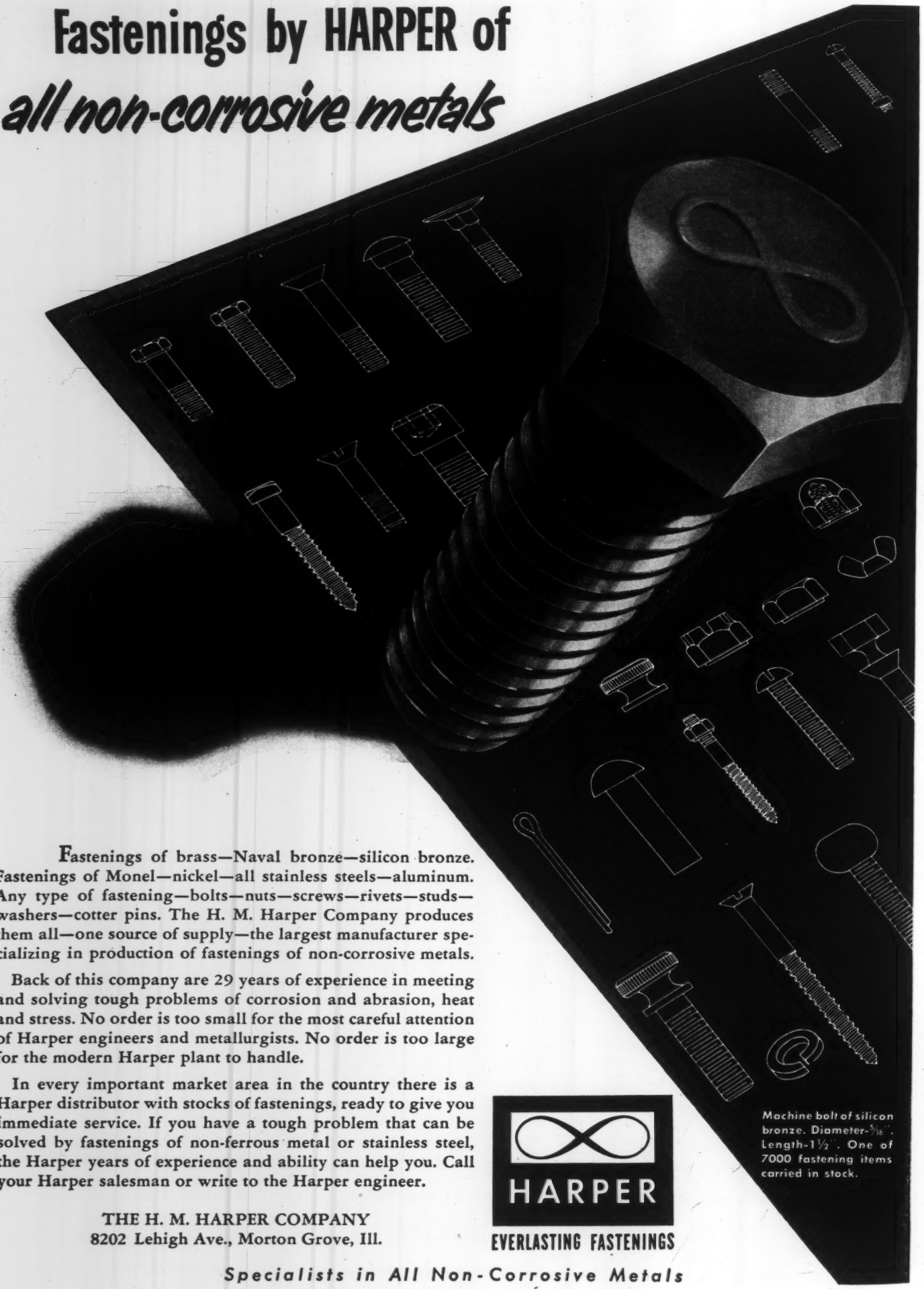
Specify Worthington Standard Products for *Your* Equipment

PUMPS:	AIR COMPRESSORS:	V-BELT DRIVES:	VARIABLE SPEED DRIVES:
CENTRIFUGAL, ROTARY, STEAM, POWER	AIR-COOLED, WATER-COOLED	QD SHEAVES AND V-BELTS	WORTHINGTON ALLSPEED

WORTHINGTON

Multi-V-Drives

Fastenings by HARPER of *all non-corrosive metals*



Machine bolt of silicon bronze. Diameter-5/16". Length-1½". One of 7000 fastening items carried in stock.

Fastenings of brass—Naval bronze—silicon bronze. Fastenings of Monel—nickel—all stainless steels—aluminum. Any type of fastening—bolts—nuts—screws—rivets—studs—washers—cotter pins. The H. M. Harper Company produces them all—one source of supply—the largest manufacturer specializing in production of fastenings of non-corrosive metals.

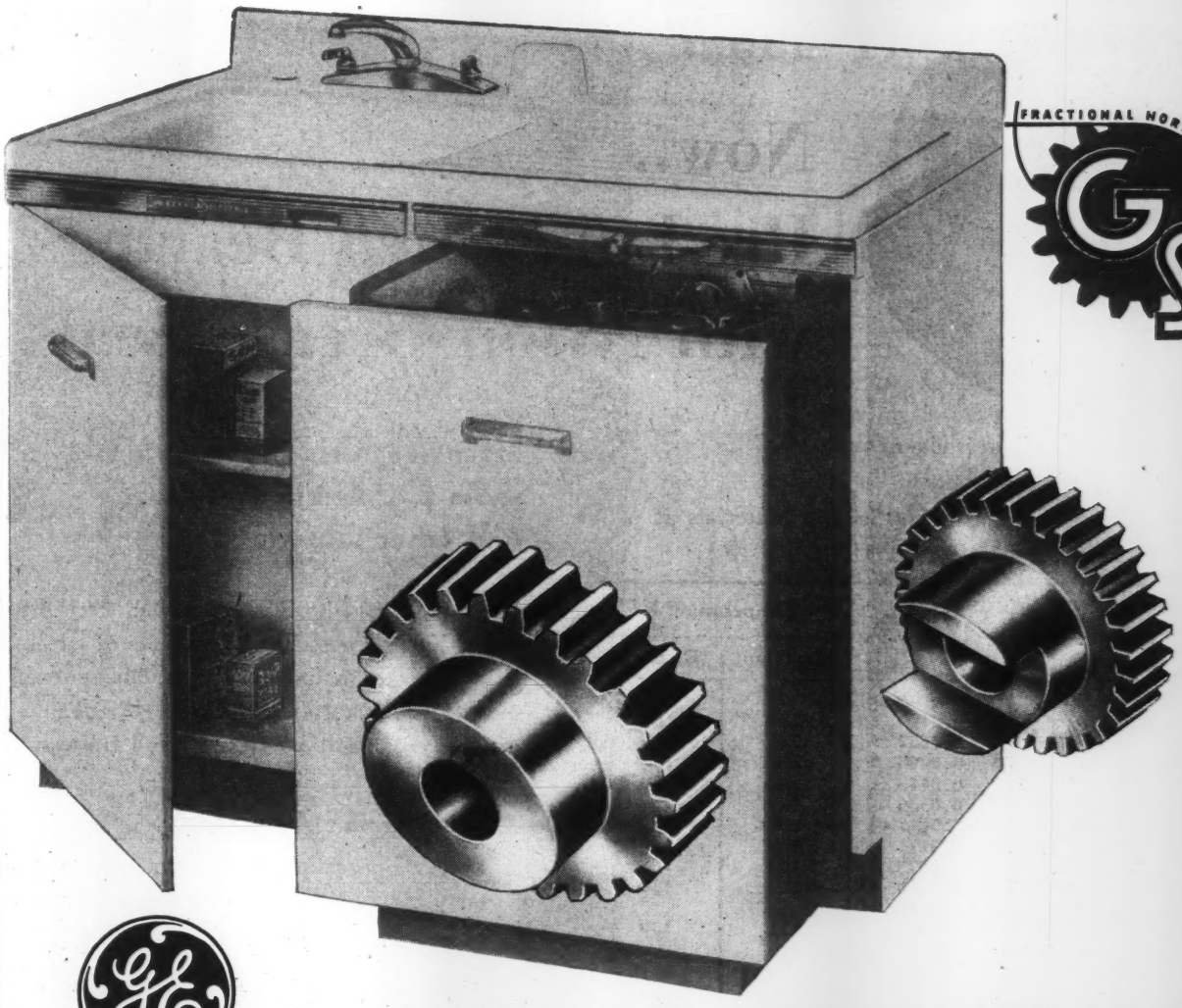
Back of this company are 29 years of experience in meeting and solving tough problems of corrosion and abrasion, heat and stress. No order is too small for the most careful attention of Harper engineers and metallurgists. No order is too large for the modern Harper plant to handle.

In every important market area in the country there is a Harper distributor with stocks of fastenings, ready to give you immediate service. If you have a tough problem that can be solved by fastenings of non-ferrous metal or stainless steel, the Harper years of experience and ability can help you. Call your Harper salesman or write to the Harper engineer.

THE H. M. HARPER COMPANY
8202 Lehigh Ave., Morton Grove, Ill.

HARPER
EVERLASTING FASTENINGS

Specialists in All Non-Corrosive Metals



FRACTIONAL HORSEPOWER GEARING

Dishwasher Assures Top Performance With G.S. Gears

The name GENERAL ELECTRIC and the familiar G.E. trademark have long been famous for top-quality performance and materials *plus* long-lasting dependability. The new G.E. Automatic Dishwasher is no exception! G.S. Fractional Horsepower Gearing is a very important factor in the soft, purring performance of this excellent appliance. G.S. craftsmen take pardonable pride in UNIFORMLY mass-producing Gears to such exacting specifications for so distinguished a manufacturer! ★ If smoother, quieter, longer-lived Small Gearing is a consideration in YOUR business, by all means entrust your needs to the long, successful experience and large, modern facilities of G.S. Call us in at the drawing-board stage. Let our specialists lend you valuable aid in the design and most economical *quantity* production of the Gearing best suited to your requirements.

SEND FOR.. the G.S. 6-page illustrated folder. It describes and illustrates G.S. facilities, Small Gearing and applications, together with handy charts. Will you ask for it on company stationery, please? No obligation, of course.

GEAR Specialties, Inc.

Spurs · Spirals · Helicals · Bevels · Internals · Worm Gearing · Racks · Thread Grinding

2635 WEST MEDILL AVENUE · CHICAGO 47, ILLINOIS

MEMBER OF AGMA

WORLD'S LARGEST EXCLUSIVE MANUFACTURERS OF FRACTIONAL HORSEPOWER GEARS

Now... Pre-Lubricated Bearings with Nylon Grease Seals

Comparative Efficiency of Bearing Sealing Materials at High Operating Speeds

Type of Seal	Type of Grease	Grease loss, gm	Temperature, F	
			Maximum	Running
Nylon	M–24	0.0498	233	130
Nylon	M–24	0.0262	225	160
Nylon	M–24	0.0246	225	150
Nylon	M–24	0.0445	205	130
Nylon	Andox C	0.0330	170	150
Nylon	M–24	0.0447	220	145
Nylon	M–24	0.0171	160	140
Nylon	M–24	0.0275	180	165
Fairprene	M–24	0.3563	300	180
Fairprene	M–24	0.3868	...	...
Fairprene	M–24	0.3751	235	130
Buna–N	Andox C	0.0246	...	...
Buna–N	Andox C	0.5082	...	...
Buna–N	Andox C	0.0280	...	...
Buna–N	Andox C	0.0636	275	275

Endurance of Nylon Seals Under Load

Length of test, hr	Type of grease	Grease loss, gm	Condition of	
			Seal	Bearing
67	ANG–25	0.0322	Excellent	Excellent
67	ANG–25	0.0059	Excellent	Excellent
578 1/2	ANG–25	0.1391	Excellent	Excellent
578 1/2	ANG–25	0.0498	Excellent	Excellent
558	M–24	0.005	Excellent	Excellent
558	M–24	0.0105	Excellent	Excellent
214 1/2	M–24	0.0097	Excellent	Excellent

Efficiency of Nylon Seals Under Eccentric Loads

Seal	Cage	Grease	Temperature, F		Length of test, hr	Grease loss
			Maximum	Running		
Nylon	Nylon	S–58	270	270	241	0.3645
Nylon	Nylon	S–58	260	260	47	0.500
Nylon	Nylon	S–58	260	260	24	0.370
Felt	Steel	S–58	270	270	24	2.52
Felt	Steel	S–58	290	290	24	1.54
Felt	Steel	S–58	260	260	24	0.32
Felt	Steel	S–58	300	250	24	1.85

Extensive tests prove nylon seals preferable to rubber and other materials

If you use pre-lubricated, sealed bearings you'll be interested in the results of extensive tests conducted by Schatz. These tests, on nylon and other common sealing materials, revealed that nylon offered these advantages:

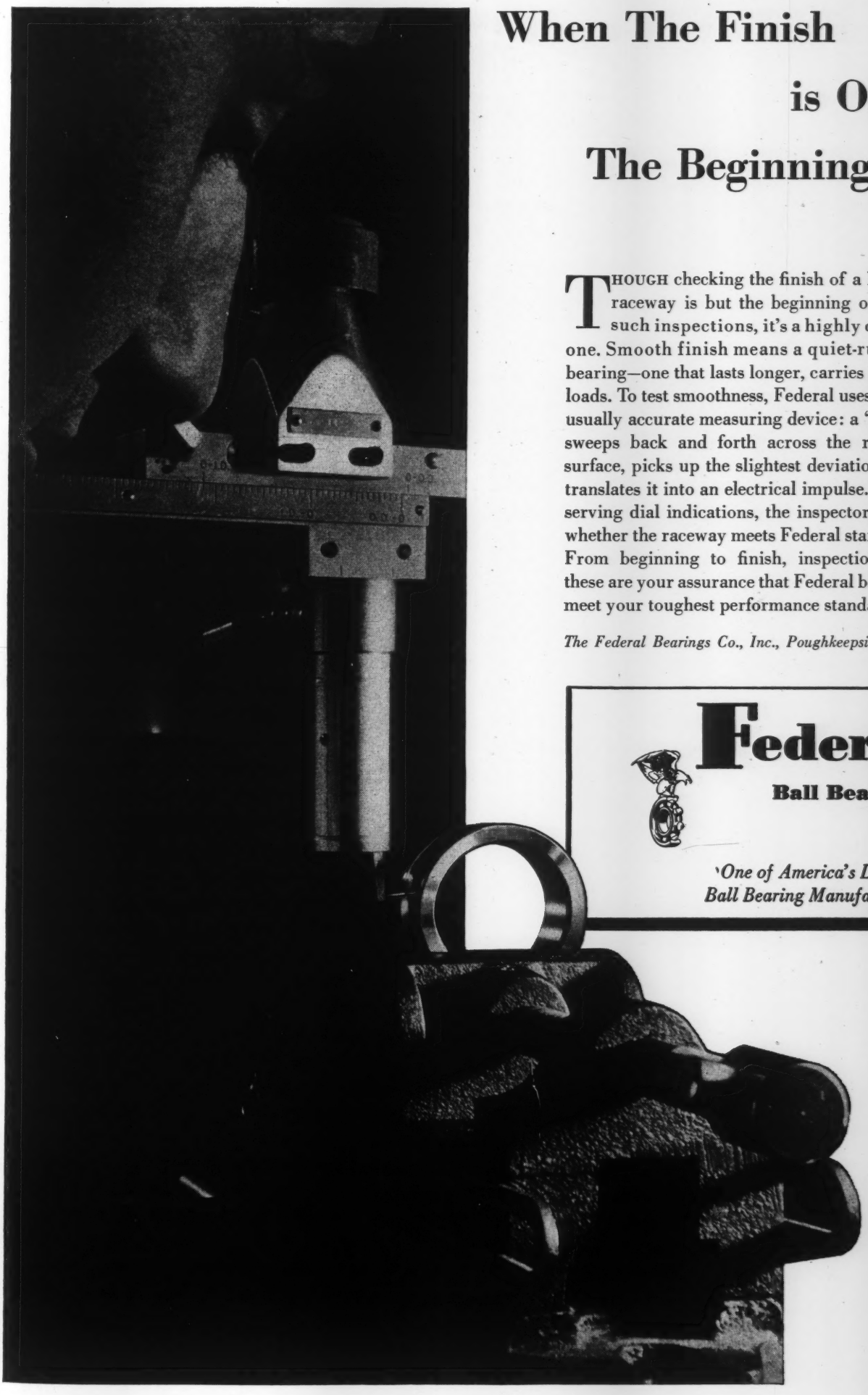
1. Lower grease loss
2. Lower operating temperature (particularly the *initial* temperature)
3. Lower torque

The efficiency of nylon as a sealing material is shown conclusively by the tables at the left. The efficiency of Schatz "Commercial" bearings is shown by their widespread usage wherever low-cost bearings are needed. And now, Schatz pre-lubricated, nylon-sealed bearings are increasingly demanded—wherever the threat of poor maintenance, or exposure to dirt and grit might affect bearing operation.

If you'd like to learn more about nylon grease seals—and how these tests were made—write for a copy of "Now: Nylon Parts for Ball Bearings," a reprint of a recent article from *Product Engineering*. It's yours for the asking.

SCHATZ "Commercial" BALL BEARINGS

THE SCHATZ MANUFACTURING COMPANY • 6760 FAIRVIEW AVENUE, POUGHKEEPSIE, N. Y.



When The Finish is Only The Beginning

THOUGH checking the finish of a bearing raceway is but the beginning of many such inspections, it's a highly critical one. Smooth finish means a quiet-running bearing—one that lasts longer, carries heavier loads. To test smoothness, Federal uses an unusually accurate measuring device: a "feeler" sweeps back and forth across the raceway surface, picks up the slightest deviation, then translates it into an electrical impulse. By observing dial indications, the inspector knows whether the raceway meets Federal standards. From beginning to finish, inspections like these are your assurance that Federal bearings meet your toughest performance standards.

The Federal Bearings Co., Inc., Poughkeepsie, N. Y.

Federal

Ball Bearings

One of America's Leading Ball Bearing Manufacturers

National Research Corporation

Announces

the formation of VACUUM METALS CORPORATION

U. S. A.'s Sole Commercial Source of Vacuum Melted Metals

Vacuum Metals Corporation has been formed to supply specialty metals and alloys for applications of high performance in terms of physical, chemical or electrical properties.

Vacuum melting techniques developed by National Research are used to produce metals of higher purity and alloys held to closer composition tolerances than ever before achieved commercially.

Organized by National Research as a wholly-owned subsidiary, Vacuum Metals Corporation now has facilities for vacuum melting more than five tons per day of metals such as copper, nickel, molybdenum or iron.

The unique properties of vacuum melted pure metals and alloys are particularly useful in applications such as electronic and electrical parts, magnetic materials, bearing materials, diaphragms, instrument components, laboratory standards and Atomic Energy projects.

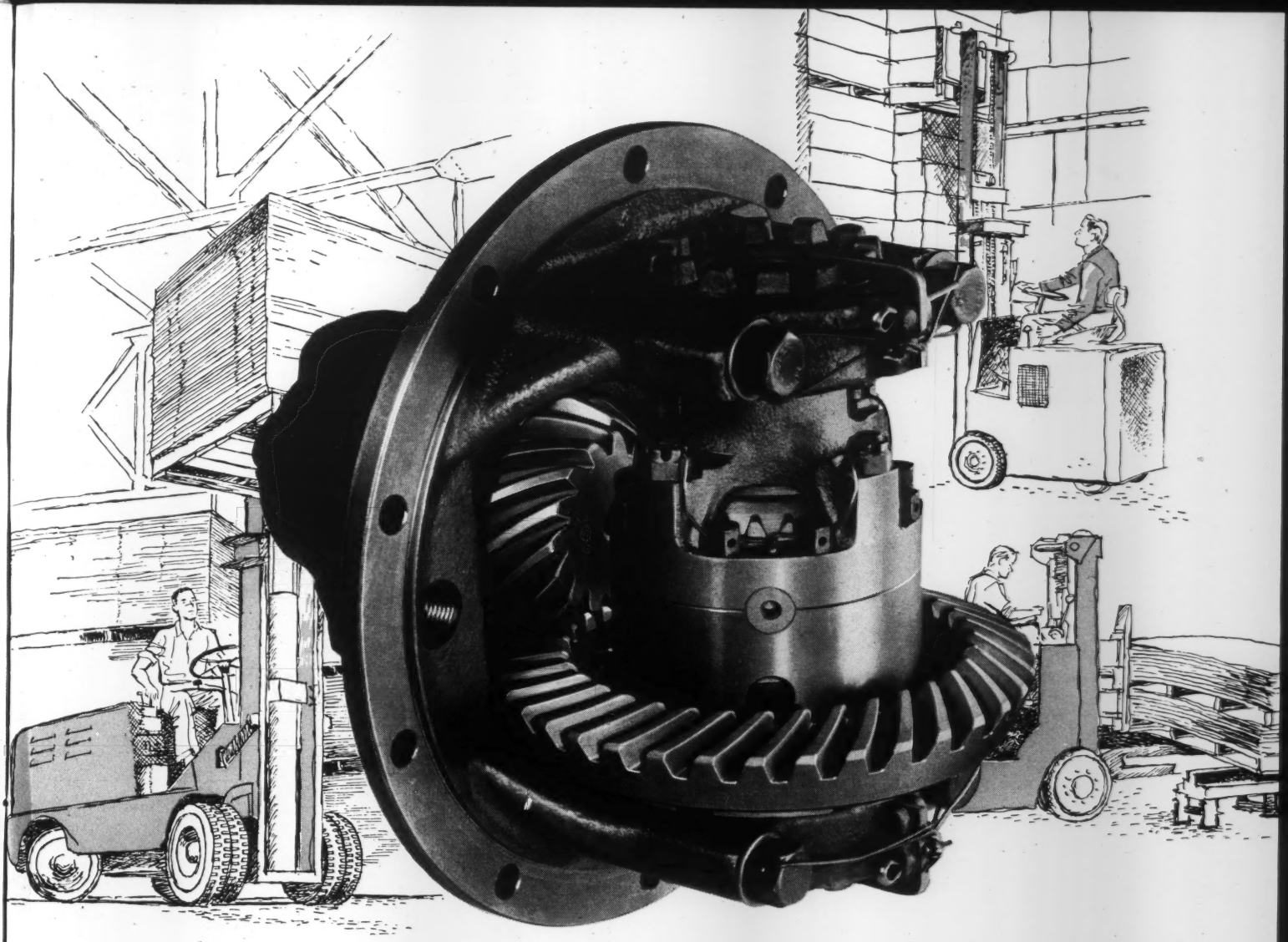
Write to us for further information about our facilities.

VACUUM METALS CORPORATION

Subsidiary of National Research Corporation

70 MEMORIAL DRIVE • CAMBRIDGE 42, MASSACHUSETTS

HIGH PURITY METALS • HIGH VACUUM CASTING • SPECIAL ALLOYS • GF (Gas Free) METALS



Muscle for America's favorite WORK HORSE

A great development of all-round usefulness to American industry is the fork lift-truck. Today, these swift, efficient machines are pacing the flow of materials in almost every American industry.

In thousands of fork lift-trucks you'll find transmission and differential assemblies made by Automotive Gear Works, Inc. Few gears of any type are exposed to such constant, heavy-duty use. This is particularly true now with increased three-shift production; with trucks working on every kind of flooring and terrain, rough or smooth, indoors or outdoors; and often handling loads greater than recommended capacities. Even under these circumstances "Double Diamonds" are providing dependable, trouble-free "muscle" for hosts of these hustling work horses.

The fact that "Double Diamond" Gears are preferred by leading fork lift-truck manufacturers may suggest the advisability of calling in a "Double Diamond" engineer when you next need gears of the many types we manufacture.

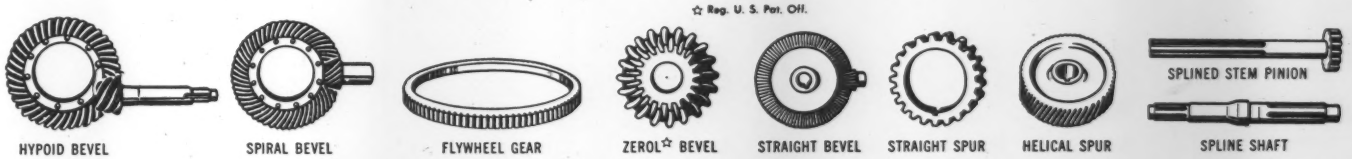
DOUBLE DIAMOND TRADE MARK GEARS

AUTOMOTIVE GEAR WORKS

RICHMOND, INDIANA

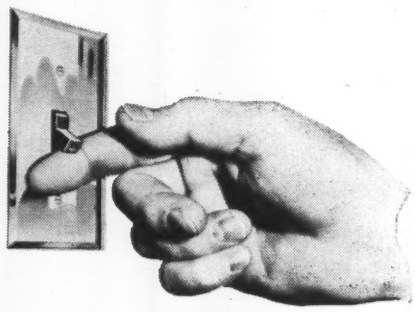
FOR AUTOMOTIVE, FARM EQUIPMENT AND GENERAL INDUSTRIAL APPLICATIONS

☆ Reg. U. S. Pat. Off.



HYPOID BEVEL · SPIRAL BEVEL · FLYWHEEL GEAR · ZEROL☆ BEVEL · STRAIGHT BEVEL · STRAIGHT SPUR · HELICAL SPUR · SPLINE SHAFT

Gloom chaser . . . that works

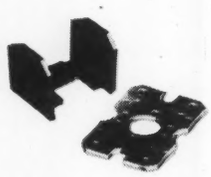


Fair weather or foul, when you flip a light switch you *expect* light. You take it for granted. Actually, like a touchdown in football, the result is the triumph of teamwork in electrical apparatus.

The power company is the captain. The players include the manufacturers of generators, transformers, switch gear, and electrical fixtures. But an *unseen essential* called *Synthane* is present, too.

Synthane is a laminated plastic. It is an excellent electrical insulator. It is also a mechanical material that combines light weight and strength, a chemical-resistant material that machines easily.

Send for the complete Synthane Catalog. Then, if you find Synthane a material you can use, we will be glad to help you with design, sheets, rods, tubes or fabricated parts. Synthane Corporation, 5 River Road, Oaks, Pennsylvania.



Insulator (left) made from Grade X Black Synthane for Square D Company and switch mounting plate made for Cutler-Hammer Inc. of Grade GLCC-M Synthane. Both parts require good electrical characteristics.

Synthane-one of industry's unseen essentials

SYNTHANE

LAMINATED PLASTICS

Further Information?

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YOUR NAME _____ TITLE _____

COMPANY _____

ADDRESS _____

CITY _____ STATE _____

6-52

FIRST CLASS
PERMIT No. 36
(Sec. 34.9 P.L.&R.)
Cleveland, Ohio

BUSINESS REPLY CARD
No Postage Stamp Necessary if Mailed in the United States

4c POSTAGE WILL BE PAID BY—

MACHINE DESIGN
Penton Building
Cleveland 13, Ohio

Reader's Service Dept.

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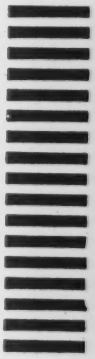

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NEED PLASTIC PARTS THAT CAN TAKE PUNISHMENT?

Do you have an application where toughness and resistance to shock are essential? Must the part withstand sharp impact? Must it resist the action of water . . . or oil . . . or chemicals?

If you're confronted with any or all of these problems there is a good chance that the right plastic materials can help you. For example:

(A) The washing machine agitator has to stand continuous mechanical stress in use. At the same time it must resist moisture and the chemical action of soaps and detergents. The specially formulated phenolic material yields outstanding performance.

(B) Here's a searchlight handle that must withstand sharp physical shock. The rubber phenolic material from which it is molded can really take it!

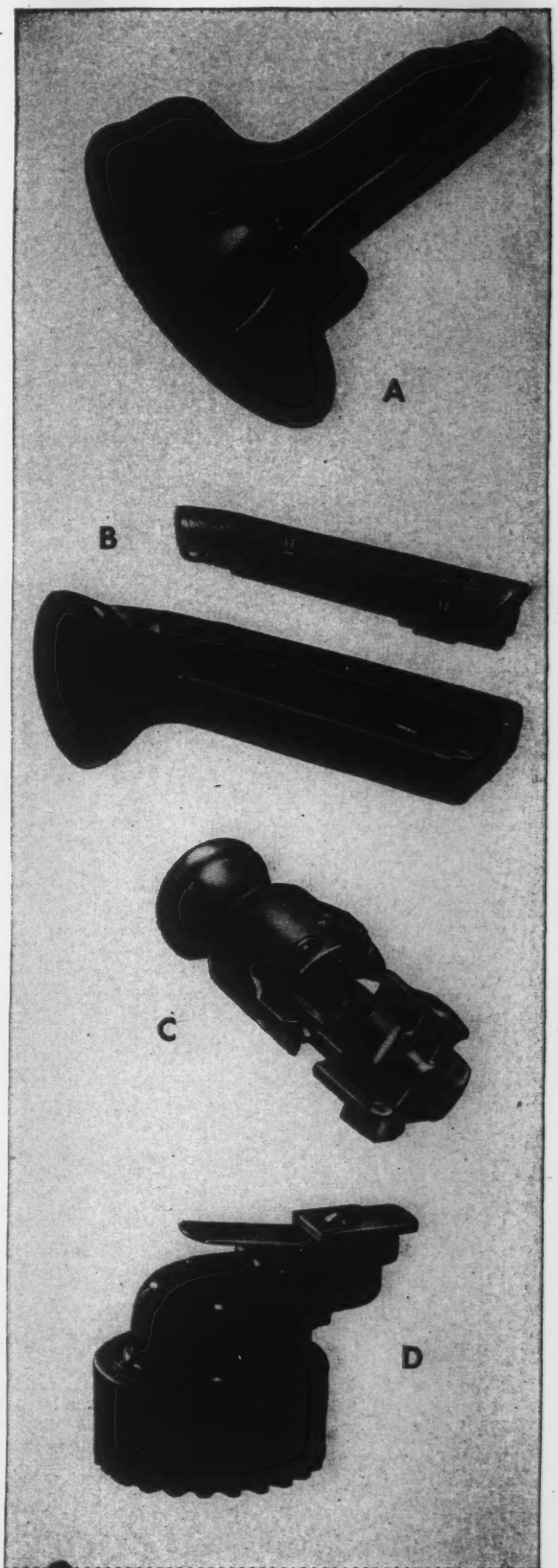
(C) This automotive brake plug is at times subjected to both physical shock and severe mechanical stresses. For this application, a canvas filled phenolic has proven highly successful.

(D) This distributor rotor withstands gear friction, ignition voltage, and the rugged service given every component in a farm tractor. Here again a phenolic plastic, properly chosen, does an outstanding job.

Getting the right material for the job is a big step in the success of any plastic application. And in choosing the one best material for the job, from the hundreds of materials and formulations now available, there is no substitute for experience.

For more than thirty-two years Chicago Molded has been solving problems like these—and hundreds of others—for many of America's largest users of plastics. That same seasoned know-how is available to you in perfecting the details of your plastic molding job. Chicago Molded's service extends to every step in the molding process—from design for molding through tool making, production, and finishing, down to the last detail of the molded component, ready for assembly into your product.

There is not the slightest obligation in talking over your needs with a Chicago Molded engineer. For prompt action, just write, wire, or phone.



CHICAGO MOLDED

PRODUCTS CORPORATION

1028 N. Kolmar Ave. Chicago 51, Illinois

CUSTOM MOLDERS OF ALL PLASTIC MATERIALS

PIN THIS TO YOUR LETTERHEAD

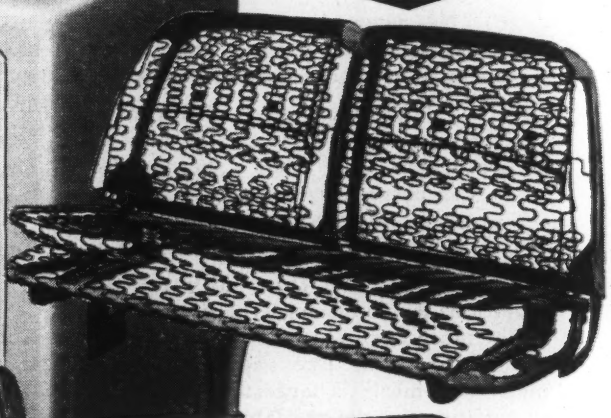
and mail it to us. We'll put you on our mailing list to receive "Plastics Progress", an interesting and informative publication containing articles about current plastic molding jobs as well as other factual data of value to the user of plastics. There's no charge or obligation.

MAIL IT TODAY

Service life increased 60 times—

The Zig Zag Wire Forming Machine is used to make springs for automotive seats and furniture.

This view of an automobile seat frame shows how the Zig Zag springs are used.



Zig Zag Spring Company

Los Angeles, California

Application: Slide block operating at 1000 cycles per minute and transmitting 4½ HP. A severe shock application that destroyed a roller bearing assembly after 4 days' operation and ordinary bearing bronze in less than a month.

Solution: **AMPCO METAL**

Results: Ampco Metal slide blocks have resisted wear for 5-years in round-the-clock service. Although close tolerances must be held, no adjustments due to wear have been required on Ampco Metal slide blocks during this period.

IT'S PRODUCTION-WISE TO AMPCO-IZE!

Flywheel — Centrifugally-cast.

Can forming die — Centrifugally-cast.

—with AMPCO* METAL

Marine reversing gear component — Sand-cast.

Sixty times longer service life and still going strong. That's the story of the slide blocks used in Zig Zag Wire Formers. And the service is tough too — involves high speeds, severe shock loads.

As a result, 25 Ampco Metal parts are used in the Zig Zag Wire Former. The company reports that in 5 years no Ampco Metal part has been replaced or adjusted in any machine, despite high operating speeds and tremendous shock loading.

Mr. Harry H. Norman, Chief Engineer of the Zig Zag Spring Company, says that the long-wearing properties of Ampco Metal have contributed substantially to the success of their Spring Former.

Take a look at your wear problems. Perhaps Ampco Metal is the low-cost solution. Easy to use because it is available in practically any form required—sheet, plate, sand and centrifugal castings, forgings, bars, tubes, welding wire and electrodes. Consult your nearest Ampco field engineer or write us for further information.

*Reg. U. S. Pat. Off., Ampco Metal, Inc.

Bushings — Centrifugally-cast Ampco Grade 18 standard bars.

Tear out this coupon and mail today!

Ampco Metal, Inc.

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AMPCO METAL INC., Dept. MD-6, Milwaukee 46, Wis.

Send me your free Ampco Metal literature giving descriptions and general applications of Ampco Metal.

Name..... Title.....

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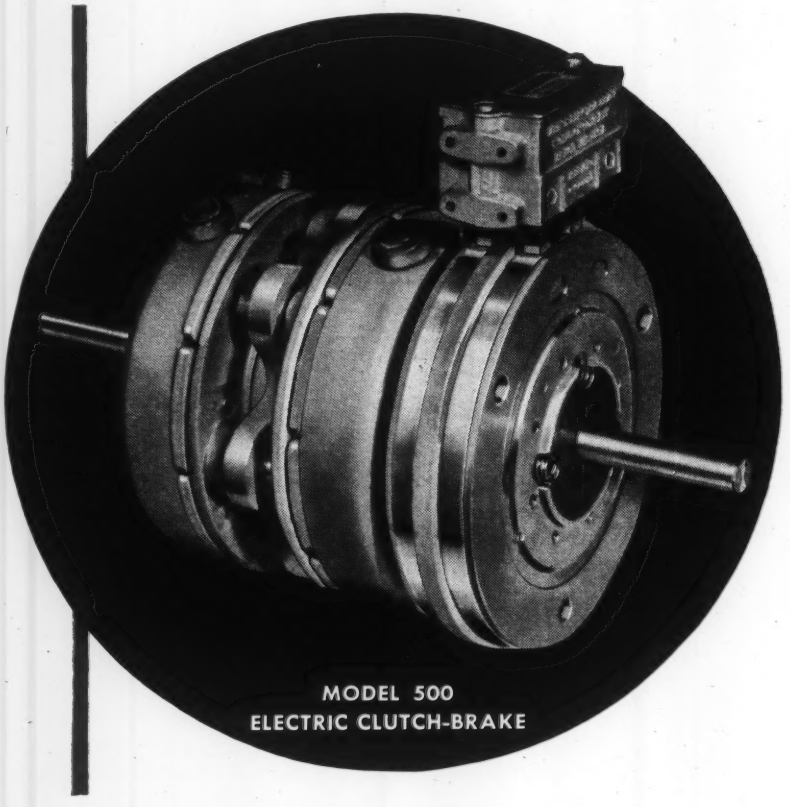
D-9

Warner Electric Clutch-Brakes provide split-second, intermittent cycling of Hautau-Turndex automation machines

WARNER
electric
motion control

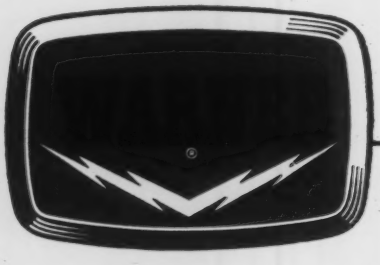
- **accelerates and decelerates master cam in less than 1/10 second**
- **provides shock-free movement—no abrupt starting, stopping or catapulting action**
- **permits automatic or manual control of index cycle**
- **accurately positions cams for constantly precise table indexing**



MODEL 500
ELECTRIC CLUTCH-BRAKE

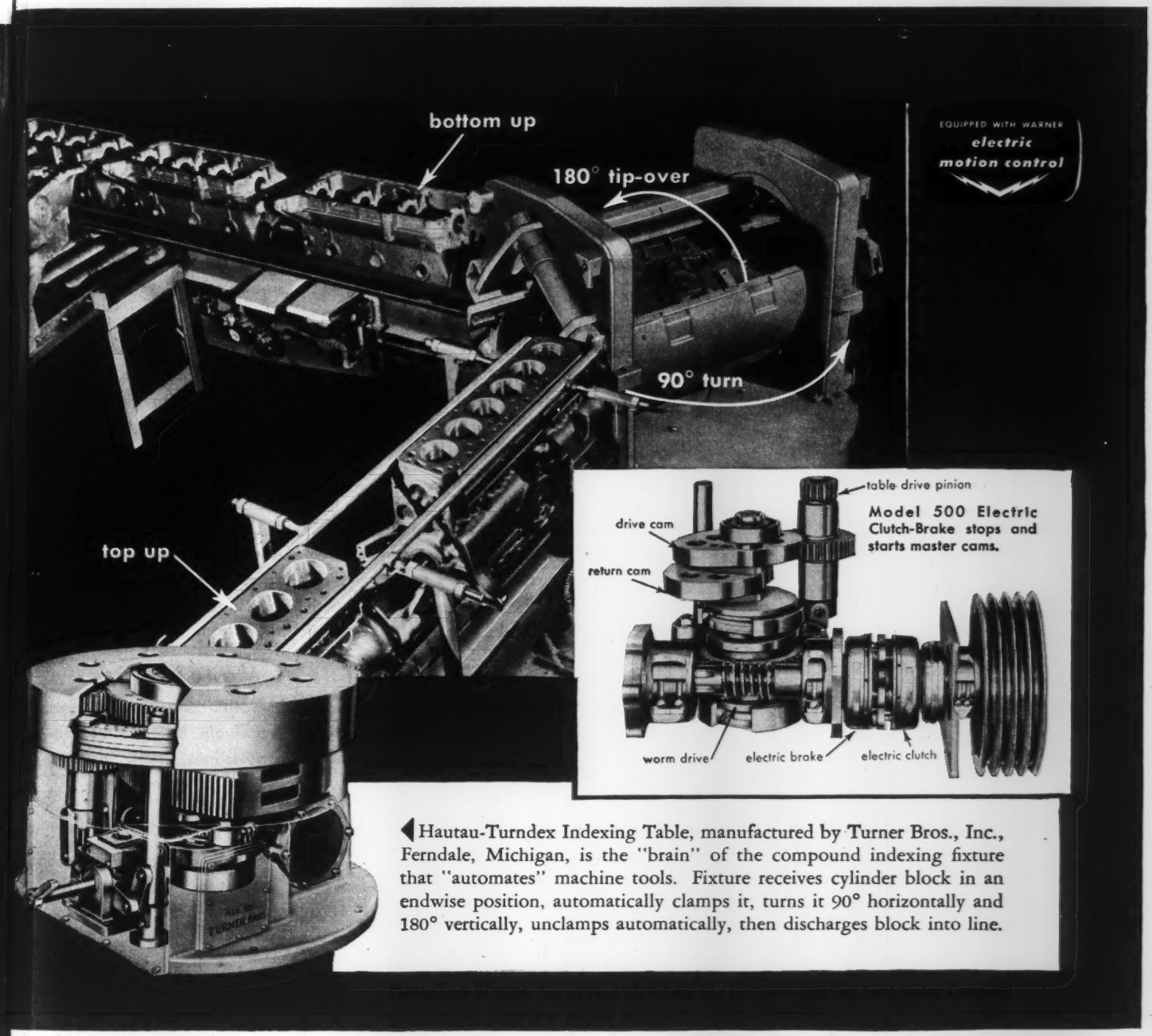
DEVELOPING machines for tomorrow's "automatic factories," design engineers are finding Warner Electric Clutches and Brakes offer new, important design opportunities because of the ease and efficiency with which they control power transmission by remote, mechanical, hydraulic, electric or electronic means. A good example is this engine-block transfer machine that "automates" a right angle, 180° tip-over production line. Compound motion is provided by a packaged, cam-actuated indexing table. The model 500 Warner Clutch-Brake provides split-second, intermittent cycle control of the master cam, automatic or manual control of the index cycle. It locates the cam with unvarying precision for each index—accelerates and decelerates it in less than *one-tenth of a second*. There is no abrupt starting, stopping or catapulting action. Result is a combination of accuracy, speed, smoothness, power and versatility never before achieved. Maximum engine block production is obtained by complete mechanical handling cycle of only 1¼ seconds!

If you have a clutching, braking, tensioning, indexing or speed control problem, investigate the new, automatic features and advantages of Warner *electric motion control!*



ELECTRIC BRAKES & CLUTCHES

FOR INDUSTRIAL APPLICATIONS



◀Hautau-Turndex Indexing Table, manufactured by Turner Bros., Inc., Ferndale, Michigan, is the "brain" of the compound indexing fixture that "automates" machine tools. Fixture receives cylinder block in an endwise position, automatically clamps it, turns it 90° horizontally and 180° vertically, unclamps automatically, then discharges block into line.

Warner Electric Brakes, Clutches and Clutch-Brakes give you new, unique simplicity of design and operation. There are only two main parts, an armature and magnet. Operation is by *electro-magnetic*, instantaneous engagement and release of friction surfaces. Torque ratings are extremely high for small size and light weight. No coasting or slipping when "locked in." Easily designed into original equipment. Readily adapted to automatic cycles and remote control by limit switches, relays, electric-eyes, pushbuttons, etc. Rate of application accurately controlled to synchronize motions—give exact degree of speed and power required.

COMPLETE ENGINEERING SERVICE : : : Warner offers complete application and design engineering service and field assistance. If you have a clutching, braking, tensioning, indexing or speed control problem, consult competent, experienced Warner brake and clutch specialists for reliable recommendations on torque, heat, electrical controls, capacity, etc.

OUR *25th* YEAR

Warner Electric Brake & Clutch Co., Dept. MD, Beloit, Wis.

☐ **Please send your FREE Bulletin No. 703-A.**

☐ **Have your representative call to discuss my problem.**

Firm Name_____

Individual_____ **Title**_____

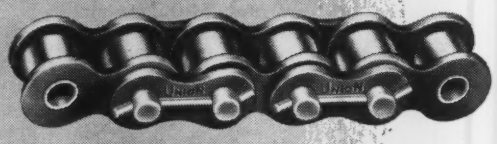
Address_____

City_____ **State**_____

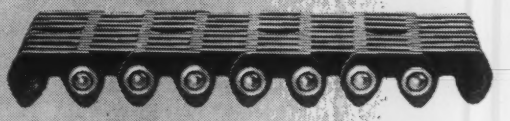
Union Chain's Performance Story PART • III

HOW UNION CHAIN RECOMMENDS

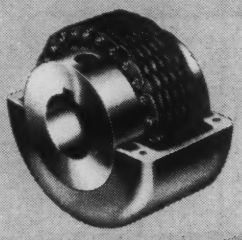
There is no need for Union Chain to recommend any steel chain but the right one—since Union Chain makes every type. Moreover, wide experience with every type of chain makes a recommendation from Union Chain's engineering staff a valuable one. Working out special chains for special cases is one of the important services offered by Union Chain, and you are invited to submit your unusual problems.



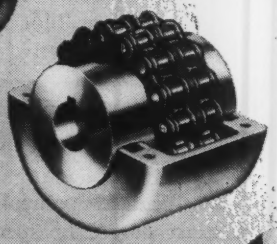
UNION ROLLER CHAIN



UNION SILENT CHAIN



UNION SILENT CHAIN FLEXIBLE COUPLING



UNION ROLLER CHAIN FLEXIBLE COUPLING

Part I - How UNION CHAIN *Specializes*

Union Chain manufactures nothing but steel sprocket chains, sprockets and attachments. Not only that—Union Chain is the only manufacturer producing every type of steel sprocket chain *exclusively*. Such specialization is the reason Union Chain consistently produces chains of the finest quality for every possible application.

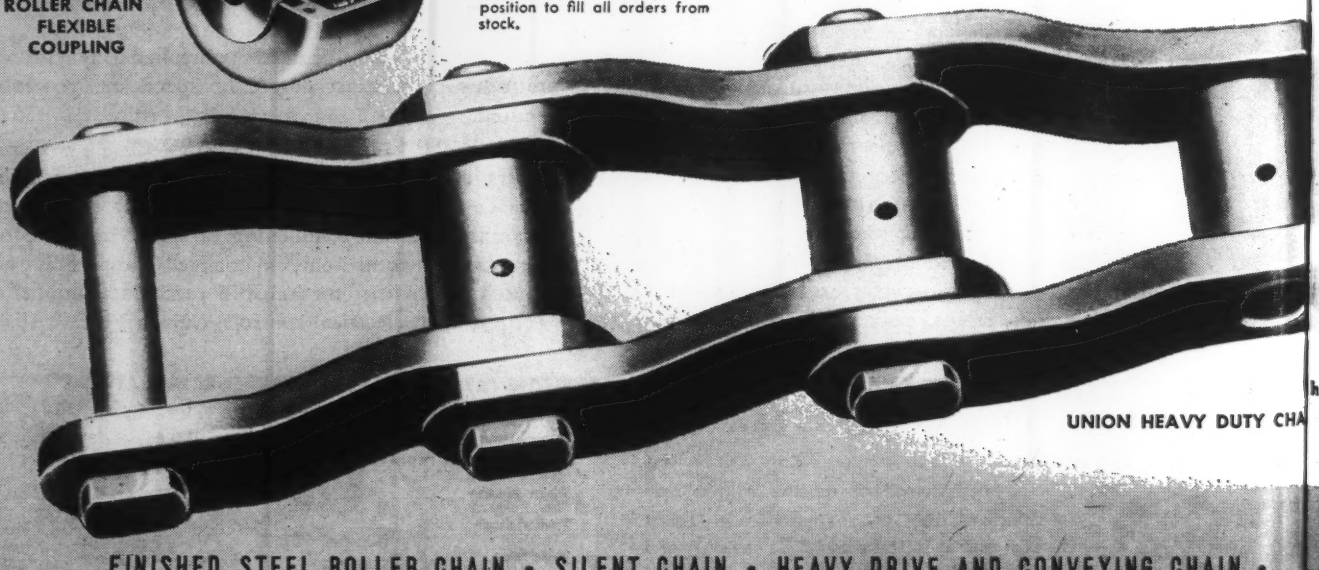
Part II - How UNION CHAIN *Manufactures*

With nothing to make but chains—with nothing to be known for but chains—Union Chain insists on meticulous accuracy in the execution of both conventional and *extra exclusively Union* manufacturing operations, thus insuring superiority of performance.

Part IV - How UNION CHAIN *Distributes*

Direct Factory Representatives are located in most industrial cities to provide a two-way communication service between customer and factory. See list at right—as well as list of Stock Carrying Distributors.*

* At the present time there is a heavy demand for many types of chain. Consequently, our distributors are not always in a position to fill all orders from stock.



UNION HEAVY DUTY CHA

FINISHED STEEL ROLLER CHAIN • SILENT CHAIN • HEAVY DRIVE AND CONVEYING CHAIN •

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Huntington Park, California

Charles A. Fowler
889 Bryant Street
San Francisco 3, California

GEORGIA
H. F. Edge
208 Walton Bldg.
Atlanta, Georgia

ILLINOIS
Union Chain & Mfg. Co.
W. Albrecht
A. C. Mahr
B. Nelson
Room 1232
53 W. Jackson Blvd.
Chicago, Illinois

INDIANA
Paul W. Huddlestun
5745 Guilford Ave.
Indianapolis 20, Indiana

LOUISIANA
F. N. Johnston Co.
236 Humble Oil Bldg.
909 S. Jefferson Davis Pkwy.
New Orleans 15, Louisiana

MASSACHUSETTS
Transmission Engineering Co.
Stanley Johnson
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Newton Highlands 61, Mass.

MICHIGAN
Union Chain & Mfg. Co.
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Basso Bldg.
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Detroit 2, Michigan

MINNESOTA
F. H. Bathke
490 N. Snelling Ave.
St. Paul, Minnesota

MISSOURI
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5473 Delmar Blvd., Rm 206
St. Louis, Missouri

Ed Schiefelbein
311 West 10th St.
Kansas City 6, Missouri

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John B. Foley
107 Tully St.
Syracuse, New York

Mays & Gleason, Inc.
50 Church St.
New York 7, New York

Potter & Dugan, Inc.
29 Wilkeson St.
Buffalo, New York

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M. R. Snyder Co.
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P. O. Box 3341
Charlotte 3, N. Carolina

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2925 Portsmouth Ave.
Cincinnati, Ohio

Union Chain & Mfg. Co.
F. H. Dalrymple
F. Smiley
Marshall Bldg.
Cleveland 13, Ohio

OREGON
J. W. Minder Chain & Gear Co.
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Portland 14, Oregon

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Plymouth, Pennsylvania

Wayne Ritter
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Pittsburgh 16, Pennsylvania

Union Chain & Mfg. Co.
John A. Shoemaker
Room 521
Schaff Bldg.
Philadelphia 2, Pennsylvania

TEXAS
Union Chain & Mfg. Co.
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E. T. Teal
205 Irwin-Keasler Bldg.
Dallas 1, Texas

VIRGINIA
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Richmond 19, Virginia

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Milwaukee 3, Wisconsin

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New York, New York

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Portland 4, Oregon

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ARKANSAS
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20 North University Street
P.O. Box 145, University Station
Fayetteville, Arkansas

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Huntington Park, California

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Motor Equipment Co.
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Standard Industrial Supply Co.
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Western Bearings, Inc.
156 South Third St.
Pocatello, Idaho

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P. O. Box 65
Danville, Illinois

W. M. Hales Co.
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Rockford, Illinois

Northern Illinois Supply Co.
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Sherer Electric Co.
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Bearing Service Co.
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Wichita 2, Kansas

W. A. Thomas Supply Co.
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Lexington, Kentucky

Sherman Bros. Mill Supply
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Louisville 2, Kentucky

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Cambridge, Massachusetts

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Lloyd Electric Co.
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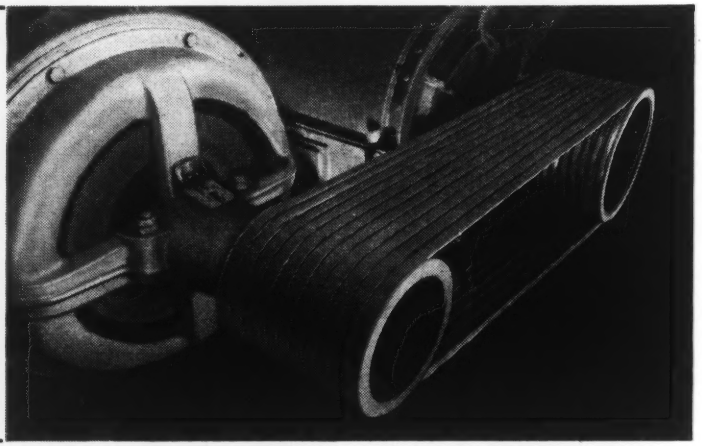
RAYBESTOS-MANHATTAN ENGINEERS OFFER HELPFUL SERVICE ON ASBESTOS AND RUBBER PRODUCTS

FRICTION MATERIALS

In the widely diversified line of friction materials made by Raybestos-Manhattan, you will find products for practically every type of machine, large or small. R/M has developed many "firsts" in this field and still carries on continuous research to discover new and better brake linings, brake blocks, segments, clutch facings and special shapes. Each product is designed to provide the unique combination of friction characteristics which one particular job requires. Whether made of sintered metal, of woven or molded asbestos, R/M friction materials are your assurance of better "Stop and Go" operation.

MECHANICAL RUBBER PRODUCTS



PACKINGS, GASKETS AND ASBESTOS TEXTILES

Raybestos-Manhattan makes a variety of asbestos textiles and a long line of packings and gaskets, two of which are shown here. R/M Vee-Flex® Rings are used in pumps, valves, compressors, hydraulic rams, etc. Their unique design automatically provides a tight seal against pressures up to 6000 psi and higher. K-68® is a neoprene compressed asbestos sheet with outstanding sealing qualities against solvents of the gasoline and Toluol types. It meets Specification AMS-3232. It contains no sulfur and is specially recommended against copper or brass in refrigeration service.

Brake Blocks, Linings and Clutch Facings

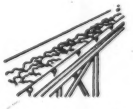
Fan Belts and Radiator Hose

Mechanical Packings and Gaskets

Abrasive and Diamond Wheels

Industrial Drive Belts

Industrial and Automotive Hose

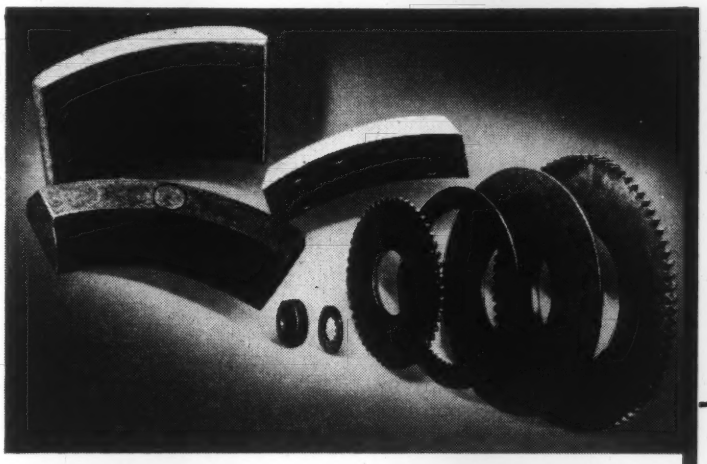


Conveyor Belts

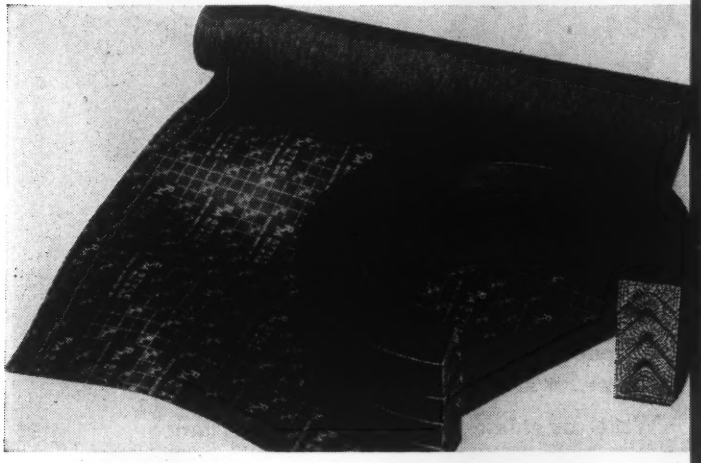
Rubber Lined and Covered Equipment

SPECIALISTS IN ASBESTOS, RUBBER, AND SINTERED

The design engineer will find in the Raybestos-Manhattan organization a unique and unusually efficient source of supply, with extensive research, engineering and manufacturing facilities. R/M is prepared to work with you in developing new parts, large or small, or to supply better standard parts.



Design engineers recommend Condor Whipcord V-Belts on important transmission drives. These men know that many common sources of "power failure" on V-Belt drives can be eliminated by selecting a reliable V-Belt. Smoothness in running, minimum inelastic stretch, and equal pull of all strength cords are factors that determine the life and productivity of a power belt. Condors also have straight sidewalls for longer wear, more grip, less slip. R/M can design mechanical rubber products specifically to meet your engineering problems . . . then mass produce them economically. R/M rubber products, including conveyor, and flat drive belts, hose, molded products, last longer—cost less.



Rubber Covered Rolls

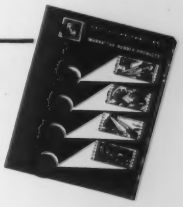
Sintered Metal Friction Elements

Asbestos Textiles

METAL PRODUCTS

To better serve you PROMPTLY

So that R/M sales, research and engineering can best coordinate to handle your problems...and so that we can serve you with least delay... please wire, phone or write the division listed under the product in which you are interested.



MECHANICAL RUBBER PRODUCTS

Manhattan Rubber Division
Raybestos-Manhattan, Inc.
Passaic, N.J.
Gregory 3-2000

PACKINGS, GASKETS AND ASBESTOS TEXTILES

Packing Division or
Asbestos Textile Division
Raybestos-Manhattan, Inc.
Manheim, Pa.
Manheim 5-2211

FRICTION MATERIALS

Equipment Sales Division
Raybestos-Manhattan, Inc.
445 Lake Shore Drive, Chicago 11, Ill.
Superior 7-5126

RAYBESTOS-MANHATTAN, INC.

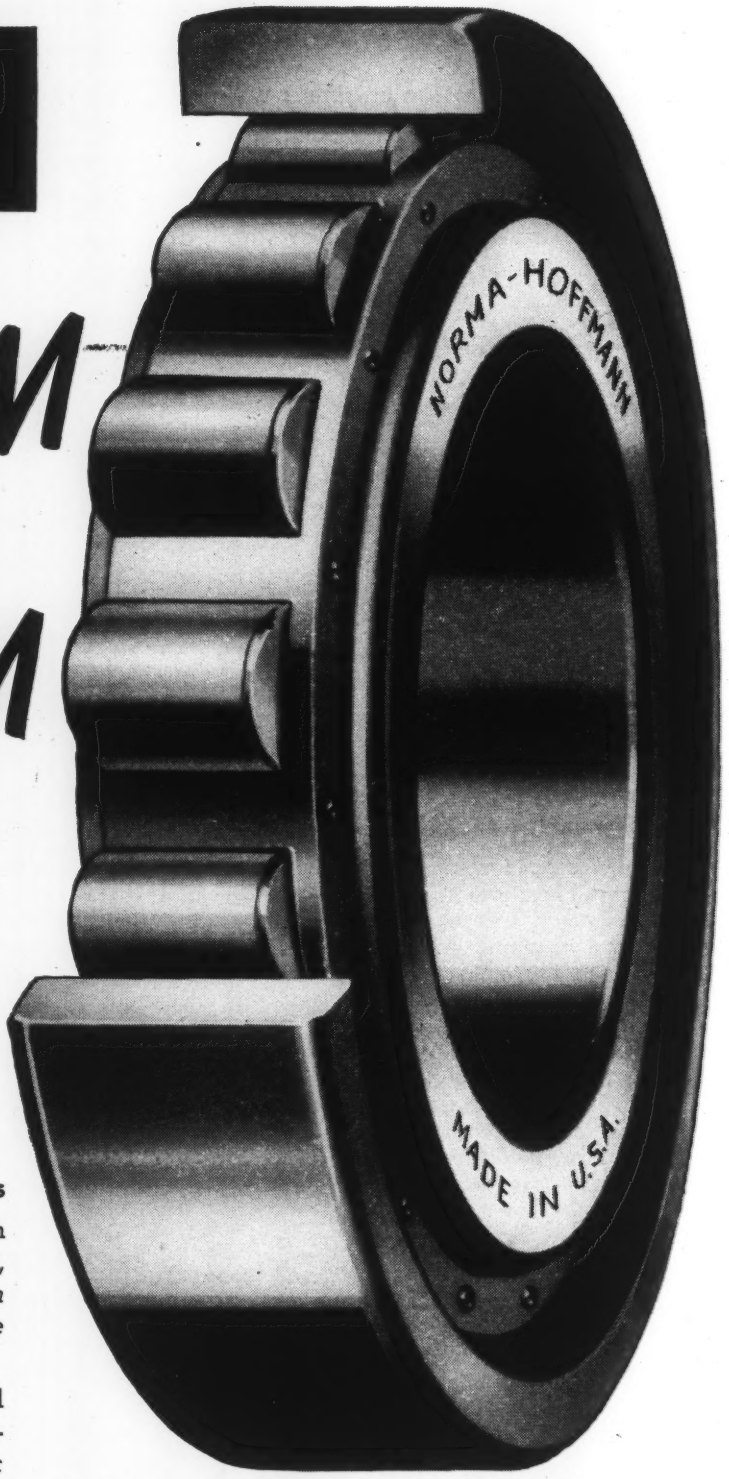
FACTORIES: Passaic, N.J. • Manheim, Pa. • Bridgeport, Conn. • No. Charleston, S.C. • Crawfordsville, Ind. • Peterborough, Ontario, Canada

Manufacturers of Mechanical Rubber Products • Packings • Brake Linings • Brake Blocks • Clutch Facings • Sintered Metal Products Fan Belts • Radiator Hose • Rubber Covered Equipment • Asbestos Textiles • Abrasive and Diamond Wheels • Bowling Balls

R/M

Norma-Hoffmann
PRECISION MADE
Roller Bearings

Give you MAXIMUM Capacity in MINIMUM Space



And equally important — they are *interchangeable* with single-row ball bearings

If your bearings must operate under such severe conditions as high speeds, heavy loads, temporary overloads, shock or vibration, *then Norma-Hoffmann Roller Bearings are the ones to use.* Here's why —

- Solid cylindrical rollers between cylindrical races provide maximum load contact area, increased steady load capacity, and a larger shock-absorbing capacity than any other type of single-row bearing.
- A safety factor margin ample for temporary overloads up to 50% beyond normal rating, as under peak loads, in unusually severe duty, or under shock conditions.
- Large contact area with the most efficient load distribution provides greater wear-resisting surfaces, assures true rolling between rollers and raceways, results in minimum friction between roller and cage.
- A lower friction coefficient under heavy load than any other type of bearing permits.
- Speedability equal to that of any ball bearing, size for size, up to 35,000 R. P. M.

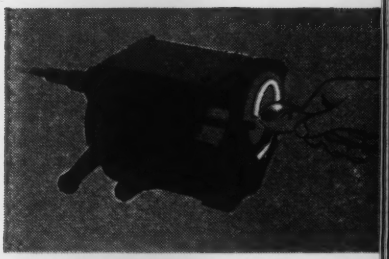
Write for catalog or engineering assistance.

NORMA-HOFFMANN BEARINGS
BALL • ROLLER • THRUST

NORMA-HOFFMANN BEARINGS CORPORATION • STAMFORD, CONN.
FIELD OFFICES: Chicago, Cleveland, Detroit, Dallas, Cincinnati, Los Angeles, San Francisco, Seattle, Kansas City, Mo.

RELIANCE SNAP RINGS REDUCE COST of Assembling Overdrive

Overdrive in millions of American cars brings greater convenience and operating economies to the motoring public. Through the use of Reliance Snap Rings in these overdrive assemblies manufacturers enjoy greater production efficiencies and lower costs. Throughout industry, Reliance Snap Rings have cut assembly time – eliminated machining operations and reduced final unit costs. You can profit through such economies in your own production – now. Reliance Snap Ring engineers will welcome an opportunity to review your assembly parts or drawings for snap ring application recommendations. For complete information write, wire or call your nearest Reliance sales office today.



Reliance snap rings lock retainer plate, gear control plate, blocker assembly, and pawl accurately into overdrive unit.

Rear main bearing locked into position by Reliance snap rings in overdrive unit.

EATON

Reliance Rings

MANUFACTURING COMPANY, RELIANCE DIVISION

OFFICE AND PLANTS • MASSILLON, OHIO

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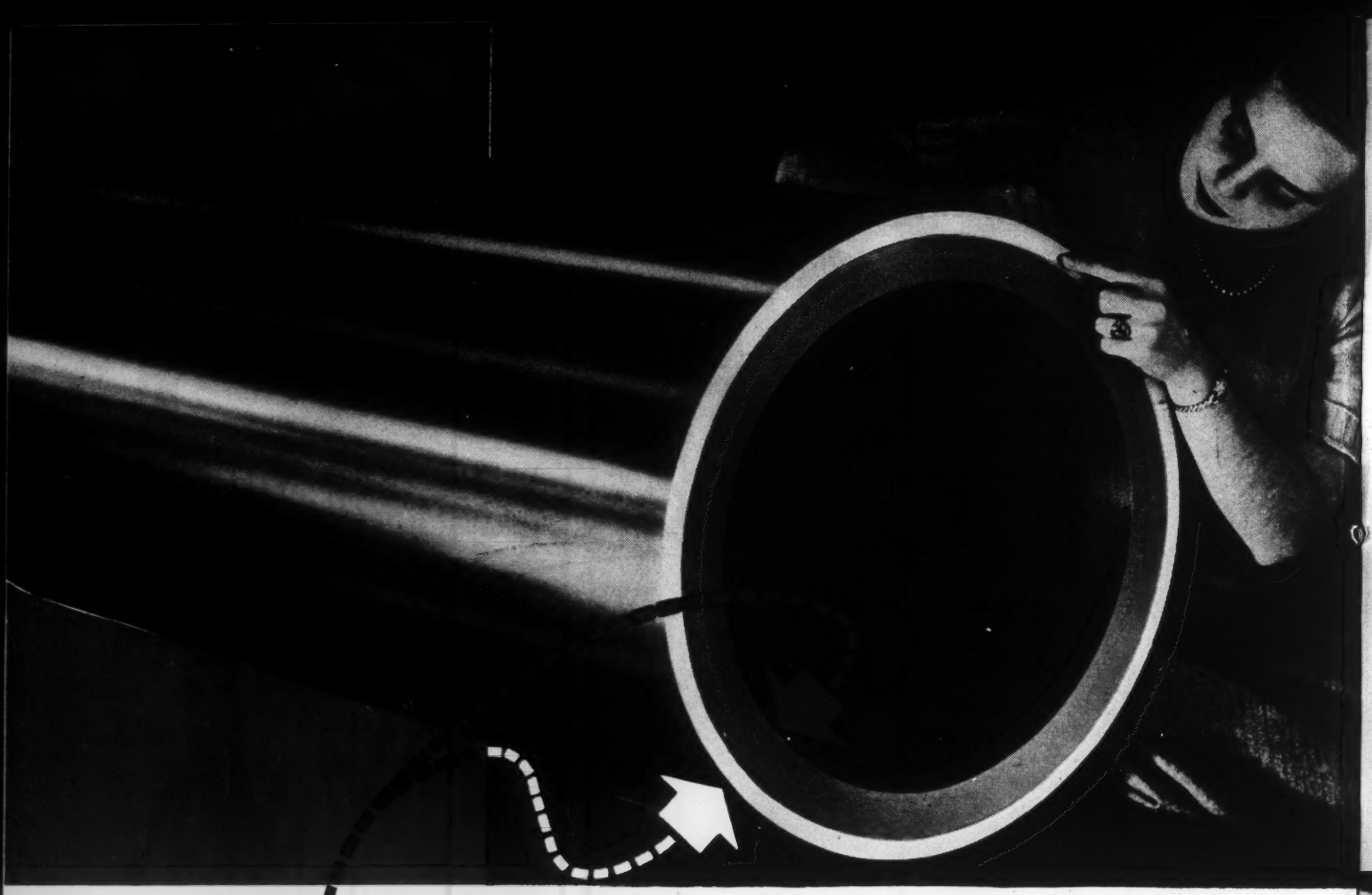


DUAL METAL—*Product Engineered*

Consider how often a *single* metal fails to provide the required metallurgical, chemical and mechanical properties . . . and the advantages of *Dual Metal* become clear.

For example, the heavy duty padder rolls we cast for the Morrison Machine Co. of Paterson, N. J., one of America's leading designers and builders of textile machinery. These rolls require *three* metallurgical characteristics. The outer shell must resist corrosion from bleaches, finishes and dyes. The inner core must be economical and easy to fabricate. And the shell and the core must be PERMANENTLY fused.

Only the *Dual Metal* process completely satisfies all of these requirements. So, using centrifugal force and temperature, two dissimilar metals are poured successively into a horizontally spinning Metal Mold. The outer shell of stainless steel is bonded to the inner core of gray iron. Together, they form a vastly superior roll . . . a roll that combines *two* metallurgical properties into a *single* structural unit that makes possible a heavier, more rigid roll at lower cost.

Today, more and more progressive equipment builders, like Morrison Machine Co., are using metal mold centrifugal castings . . . in both single and dual metal . . . to fill specific metallurgical and mechanical needs. Centrifugal casting may be the answer to *your own* problem. Write today and let's see if we can work it out together.

UNITED STATES PIPE & FOUNDRY CO.

SPECIAL PRODUCTS DIVISION U S P

Special Products Division

BURLINGTON, NEW JERSEY

AMERICA'S LARGEST PRODUCER OF CENTRIFUGALLY CAST FERROUS METAL PRODUCTS IN TUBULAR FORM

DUAL METAL
TEXTILE ROLL,
stainless steel outside
metallurgically bonded to
a gray iron core,
rough machined and ready for
shipment from our plant.

TYPES OF METAL CAST:

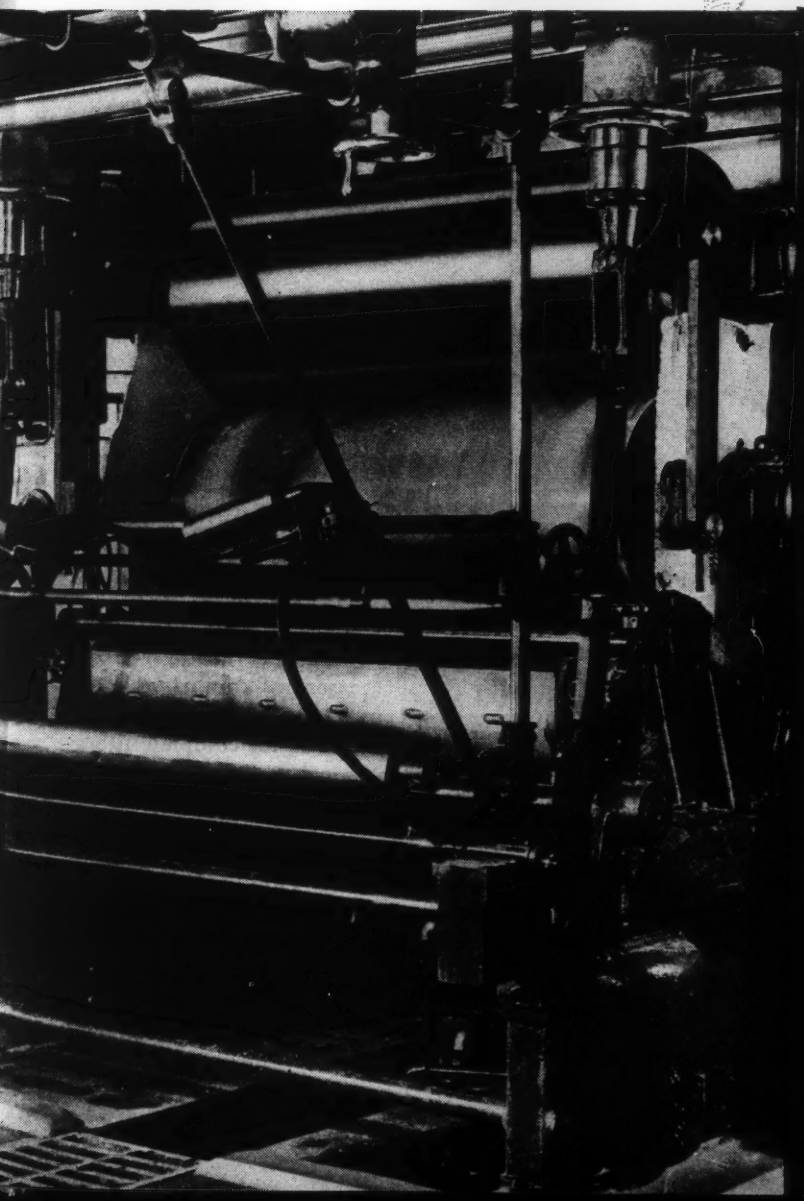
Stainless Steel—All AISI Types, plus special heat and corrosion resistant analyses.

- **Alloy Steel—all grades**
- **Carbon Steel—all grades**
- **Gray and Alloy Iron—all standard and special analyses, including Ni-Hard and Ni-Resist**
- **"Dual Metal"—Gray or alloy iron inside steel; gray iron inside chilled iron and tool steel; iron or steel inside stainless; and many other metallurgically bonded two-metal centrifugally cast combinations.**

SIZE RANGE:

Outside diameters—2½" through 30"

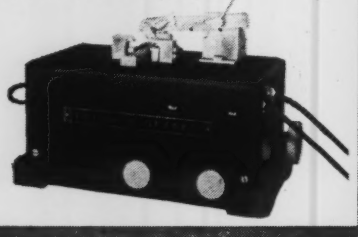
- **Wall Thickness—¼" to 4"**
- **Lengths—Up to 14'.**



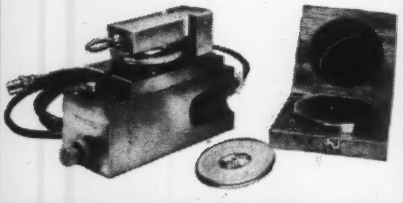
Adaptable Foundation for Countless Precision Gaging Set-Ups

TYPICAL APPLICATIONS

Special gaging fixture made by Brown & Sharpe for inspecting dimensions, side parallelism and side squareness of cutter blades. Employs 4 Gage Head Cartridges . . . used with 4 Amplifiers.



Special gaging fixture, custom-made by Brown & Sharpe, permits gaging of meter valve plate flatness to .00001", when used with Brown & Sharpe Amplifier.



Custom-made fixture, employing Brown & Sharpe Gage Head Cartridge and one Amplifier, measures major and minor I.D.'s of tapered bores; indicates internal angle accuracy.

Brown & Sharpe Gage Head Cartridge and Electronic Amplifier

Here's a really practical basis for versatile precision gaging equipment at reasonable cost.

The Brown & Sharpe Gage Head Cartridge and Electronic Amplifier provide accurate gaging, with direct-reading indications, in units of .0001" to .00001". Simple jigs or fixtures to hold the cartridge for many special gaging jobs can easily be built in your own plant. By shifting the same cartridge among a number of fixtures, you can do precision gaging of practically any length, diameter, or other dimension — with minimum investment in equipment.

Both the Gage Head Cartridge and the Electronic Amplifier are built for severe service conditions. The dustproof, moisture-proof cartridge can be safely exposed to abrasives or coolant. Write for complete literature on this multi-use precision gaging equipment. Brown & Sharpe Mfg. Co., Providence 1, R. I., U.S.A.

WE URGE BUYING THROUGH THE DISTRIBUTOR

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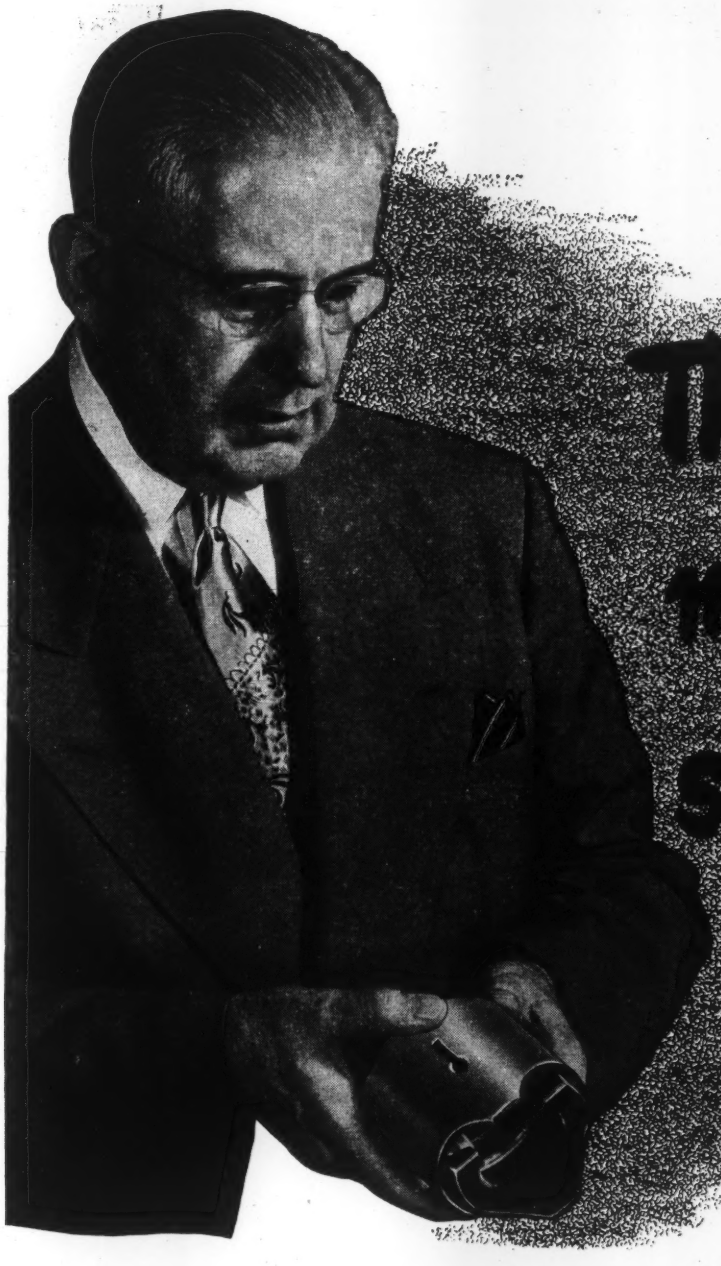
Brown & Sharpe

ANOTHER THOMPSON DEVELOPMENT

Three ring controlled aluminum pistons for high compression engines with scalloped skirt.



Thompson packs more power into smaller packages

NEW opportunities for cutting costs of intricate parts are being opened up by Thompson Products' advanced developments in casting light metals in permanent mold and high pressure dies. In many fields, ferrous castings are being replaced by more efficient light alloys of aluminum and magnesium. Records show resulting benefits to industry to stronger, more durable products requiring considerably less machining and finishing, and better heat conductivity. Through Thompson's unique developments in quality control and moulding methods, dependable uniformity from piece to piece is eliminating costly scrap losses.

Thompson's creative engineers will gladly put their many years of experience to work for you by showing where and how you, too, can simplify your operations with light metals and save on costs. Simply write Thompson Products, Inc., Light Metals Division, 2269 Ashland Road, Cleveland 3, Ohio.

Thompson Products

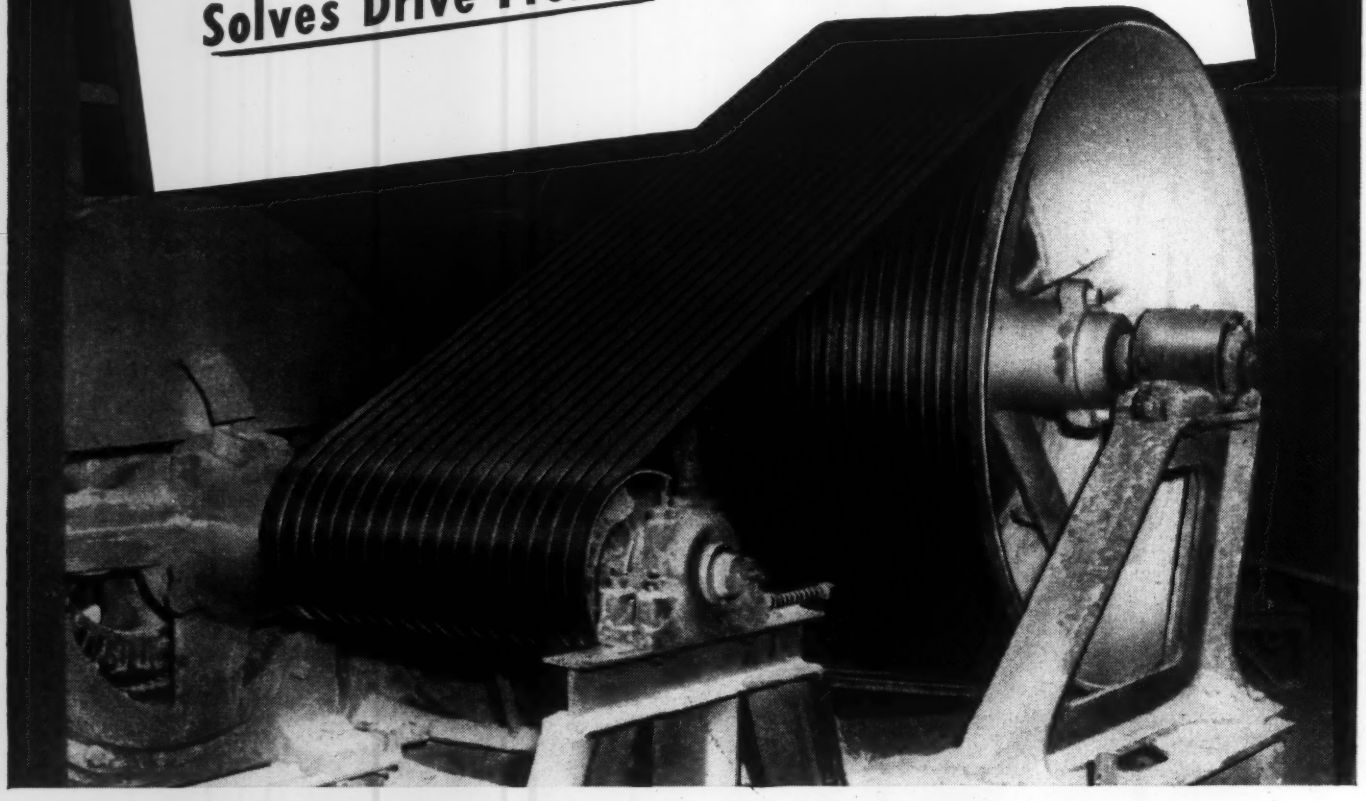
LIGHT METALS DIVISION

2269 Ashland Road • Cleveland 3, Ohio

Other Examples of How Thompson Light Metals Serve Industry: **End Frames for Fractional Horsepower Motors • Housings for Garbage Disposal Units • Fan Blades for Industrial Ventilators • Fluid Drives for Automotive Transmissions • Bazookas for Army Ordinance**

New BWH V-BELT Installation

Solves Drive Problem for Gladding McBean



Drive at pug mill of Gladding McBean & Co. Safety guard removed for photographic purposes

The Problem:

The drive at the pug mill at the Gladding McBean & Company brick plant, Pittsburg, California, is so vital to their production it cannot be out of service for any length of time. It must operate under dusty conditions which induce slippage in ordinary belts. It must be able to take very severe pulsating loads.

The Solution:

With the installation of rugged BWH Bull Dog V-Belts the problems and difficulties were completely overcome.

* * *

Do you have a drive or V-Belt problem? Call us for Bull Dog V-Belts and a space saving, dependable, trouble-free installation.

Another Quality Product of

BWH DEPENDABLE RUGGEDNESS

BOSTON WOVEN HOSE & RUBBER COMPANY

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GENERAL ELECTRIC

Announces

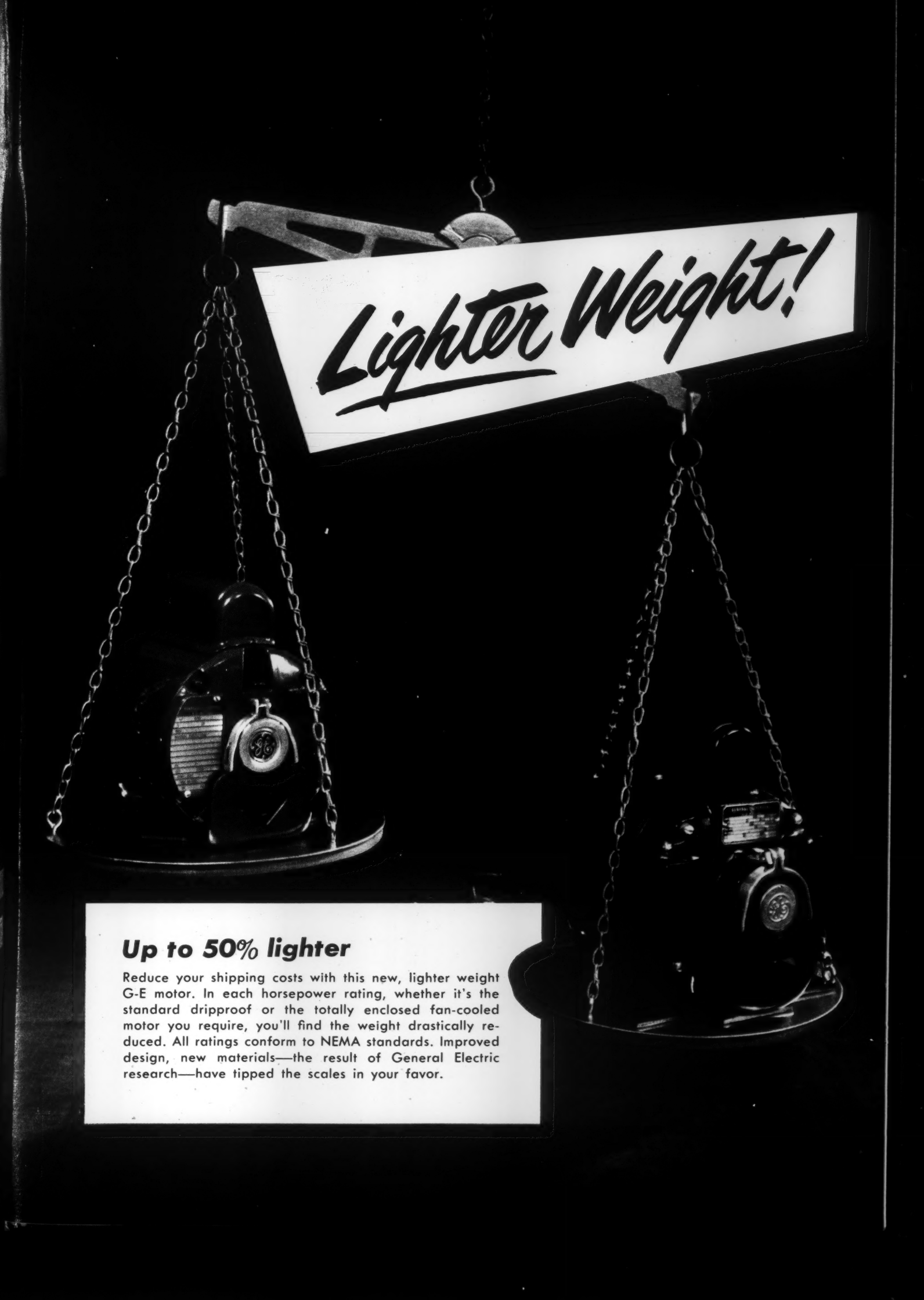
A COMPLETELY NEW FRACTIONAL HORSEPOWER MOTOR

Modern in Appearance...

AND...

Compare the old and the new

The new Form G General Electric f-hp motor requires less space—less space on driven machines—less space in storage and shipping. An entirely new ventilating system and more compact design, combined with strong but lighter metals, reduces the over-all dimensions. Throughout the line these motors are smaller, easier to mount.



Up to 50% lighter

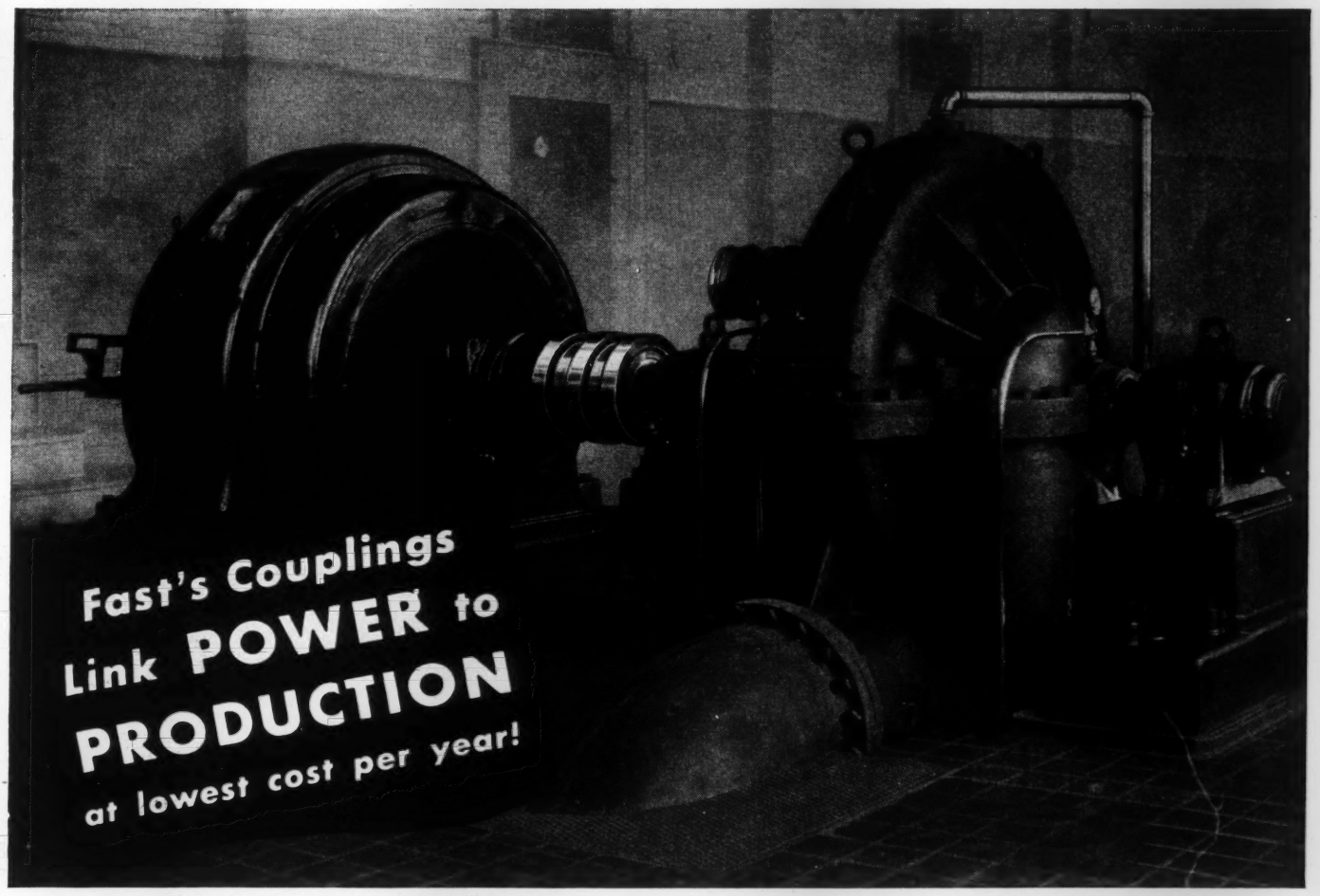
Reduce your shipping costs with this new, lighter weight G-E motor. In each horsepower rating, whether it's the standard dripproof or the totally enclosed fan-cooled motor you require, you'll find the weight drastically reduced. All ratings conform to NEMA standards. Improved design, new materials—the result of General Electric research—have tipped the scales in your favor.

All-angle operation

Mount the sleeve-bearing motor in any position. Turn it in its cradle as required—the new lubricating and ventilating systems assure you of long life with little maintenance. These features, combined with an insulating system using a newly developed Nylon material will often enable you to apply the standard sleeve-bearing motor in place of the more expensive specials. *Ask the nearest G-E office for bulletin GEA-5567 or write Section 700-112, General Electric Company, Schenectady 5, N. Y.*

GENERAL ELECTRIC

700-112



FAST'S Couplings usually outlast the equipment they connect!

ACTUAL cases on record show many Fast's Couplings are still in service after as much as 30 years of continuous operation! Time and time again, equipment has been replaced while the original Fast's Coupling remained on the job.

To you, these records of dependable, trouble-free service mean freedom from costly coupling failures when you specify Fast's. And they mean Fast's cost you far less to own and operate . . . because their cost can be amortized over long years of dependable performance.

For full details on how Fast's Couplings and Koppers Engineering Service can help you, write today for a free copy of our catalog to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* 246 Scott St., Baltimore 3, Maryland.

Here's How FAST'S Save You Money

Free Service—Koppers free engineering service assures you the right coupling for the job.

Rugged Construction—Fast's still maintains its original design, without basic change or sacrifice in size or materials. Result: freedom from expensive coupling failures.

Lowest Cost per Year—Fast's Couplings usually outlast equipment they connect. Their cost may be spread over many years!

KOPPERS®

FAST'S
THE ORIGINAL
GEAR-TYPE
Couplings

INDUSTRY'S STANDARD FOR 32 YEARS

KOPPERS COMPANY, INC., *Fast's Coupling Dept.,*
246 Scott St., Baltimore 3, Md.

Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

*Name*_____

*Company*_____

*Address*_____

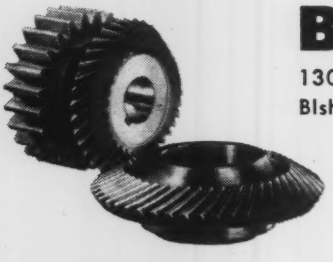
*City*_____ *Zone*____ *State*_____

above • Looking down inside you see gears ready for shot-peening and spiral conveyor which returns used shot

right • Front view with lid raised showing other gears to be shot-peened

Shot-Peening is a method of toughening gears to make them wear longer. BRAD FOOTE'S shot-peening machine, one of the largest ever made, bombards the gear with shot under pressure. As each shot strikes it compacts the metal and hardens a minute area of the gear's surface.

• Shot-peening is another service which BRAD FOOTE has available for improving the quality of gears you buy for use in your own shop... or on the equipment you make for others. It is another step in our complete gear manufacturing process which means that *"no one shares our responsibility."*



BRAD FOOTE GEAR WORKS, INC.

1309 South Cicero Avenue • Cicero 50, Illinois
BIshop 2-1070 • OLympic 2-7700

subsidiaries

AMERICAN GEAR & MFG. CO.
Phone: Lemont 920
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PITTSBURGH GEAR COMPANY
Phone: ATlantic 1-9950
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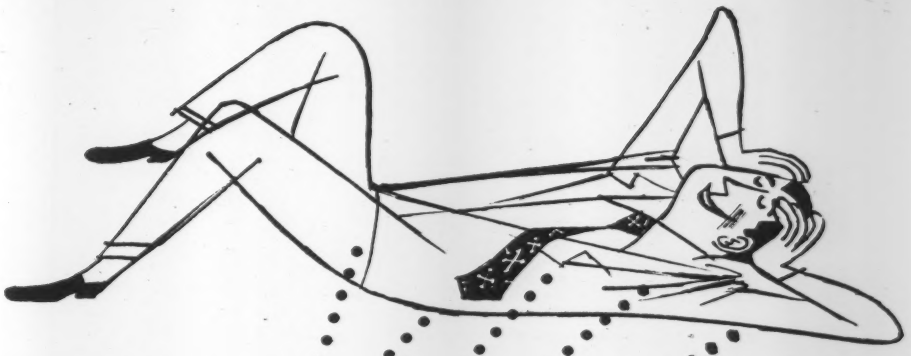


now comfort comes in a cabinet molded by GENERAL AMERICAN!

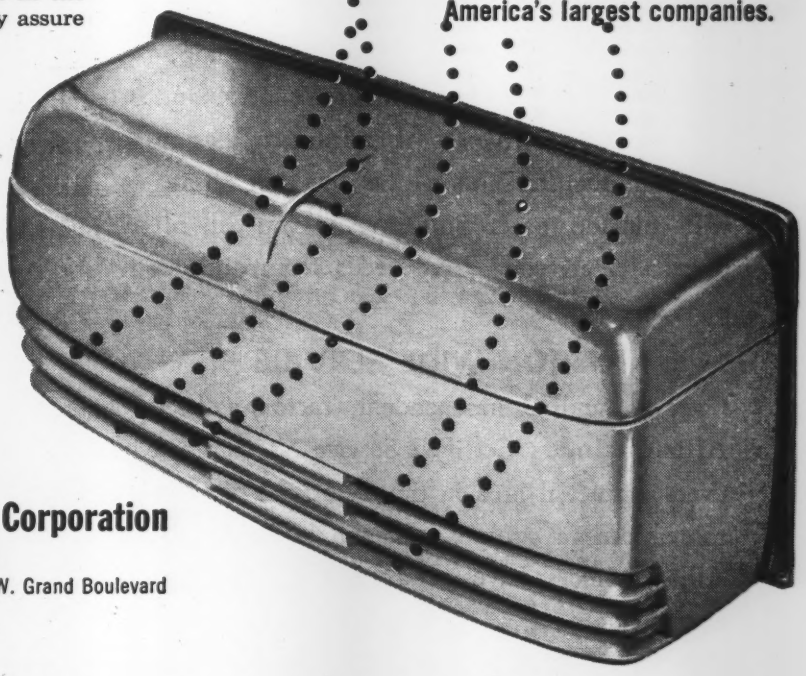
One-piece compression molding for this air conditioning cabinet . . . A large cavity, deep draw phenolic molding. Molded on a 2000 ton compression press, just one of the General American battery of presses that range from 100 tons to 2000 tons.

featuring Beauty . . . The cabinet looks beautiful and is produced at moderate cost. It's sleek, colorful and pleasant to the touch. Resistant to commercial solvents, it retains the rich surface luster with age. A cabinet worthy of the finest home or the best appointed office.

and Utility . . . The cabinet does its job well. In some cases far better than the previous material used. At present it's being produced for one of the largest air conditioning manufacturers in the country. Its dimensional and heat stability assure exact fit between joining members.

and from a technical viewpoint . . . General American has pioneered development of plastic cabinets (television, radio, etc.) and housings of far greater weight and size than any before considered practical. General American offers "large parts" users unduplicated facilities . . . and the ingenious engineering which has made this equipment perform exceptional work. More important, this combination has enabled many manufacturers to cut expenses sharply with the introduction of new plastics applications. Why not find out more about General American's facilities? There's a new brochure waiting for you. Just write and ask for it.

General American has had more than 50 years of successful experience in manufacturing for America's largest companies.



PLASTICS DIVISION GENERAL AMERICAN TRADE MARK

Plastics Division

General American Transportation Corporation

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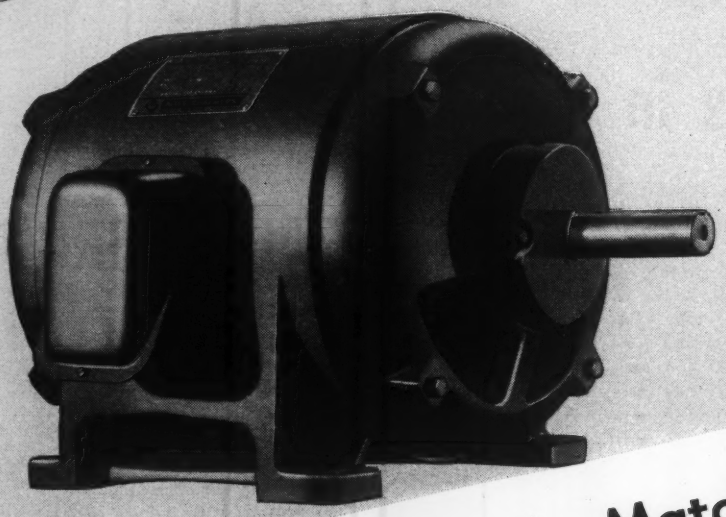
Simplify Your Drive



MOTORS

Standard open drip-proof, splash-proof, totally-enclosed, fan cooled and explosion proof. ½ hp and up, also wound rotor and dc. Special motors to meet your requirements.

Allis-Chalmers Matched Motors, Control and V-Belt Drives Save Design Time and Cut Manufacturing Cost

DRIVE DESIGN IS EASIER AND QUICKER when you use Allis-Chalmers matched components on your machines. Motor, control and *Texrope* V-belt drive are of coordinated design and manufacture. You can be sure that ratings will coincide, parts will fit. And you can fill practically all your drive needs from one dependable source.

NATION-WIDE SERVICE

Over a hundred independent, factory-assisted Allis-Chalmers Certified Service Shops cover every industrial area in the country. Your customers can get prompt, efficient service for the Allis-Chalmers drives on your machines wherever they are.

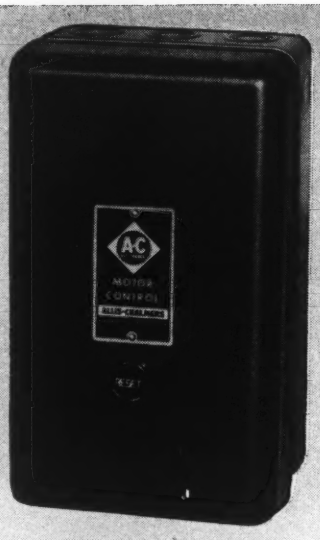
ENGINEERING HELP

Allis-Chalmers engineers are familiar with your problems because Allis-Chalmers builds many types of processing machinery itself. Call in the Allis-Chalmers representative early in your planning. He may be able to offer you valuable suggestions for improving your designs and cutting costs. No obligation, of course. A-3774

Texrope and *Vari-Pitch* are Allis-Chalmers trademarks.

ALLIS-

Design Problems!

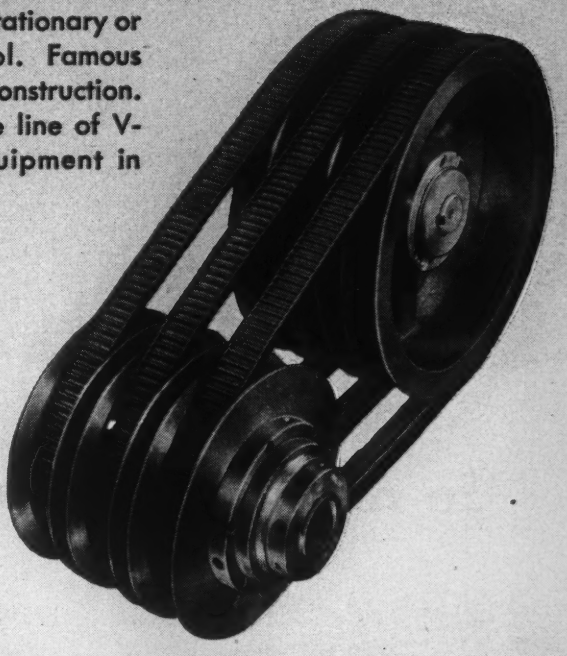


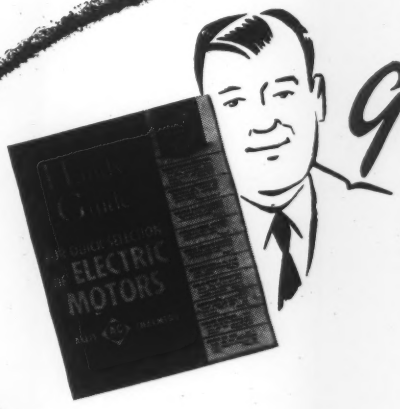
CONTROL

Complete matched control for any motor including manual and magnetic starters, push-buttons, variable speed control.

Texrope V-BELT DRIVES

Fixed speed and *Vari-Pitch* sheaves with stationary or motion control. Famous grommet belt construction. Most complete line of V-belt drive equipment in the industry.





Get the Help You Need!

Allis-Chalmers representatives in every industrial center are at your command. Just call the office nearest you.

Write Allis-Chalmers, Milwaukee 1, Wisconsin for helpful literature.

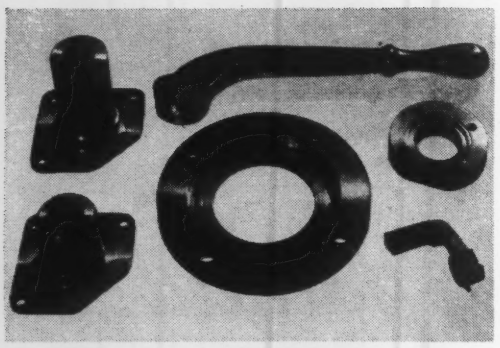
Allis-Chalmers Motors and Control	51B6052
Texrope V-Belt Drives	20B6051

CHALMERS

A-C ALLIS-CHALMERS

"fully satisfies loading conditions..."

So again the choice is: GRAY IRON



Specify gray iron for smaller operating parts, too, like these components of the torque control pictured above.

MAKE IT BETTER WITH GRAY IRON

Second largest industry in the metal-working field

BECAUSE GRAY IRON DOES THE JOB AT LOWER COST, the designer specified gray iron castings for this torque control housing. He knows you can't beat gray iron for ready machinability at a specified pressure strength level.

GRAY IRON GIVES YOU ALL THESE ADDED PRODUCTION ADVANTAGES: Castability, rigidity, low notch sensitivity, wear-, heat- and corrosion resistance, durability, vibration absorption, wide strength range.

SO SPECIFY GRAY IRON when you need a part that must meet many structural and functional requirements—with economy. We know gray iron will satisfactorily serve your needs.

SCRAP IS NEEDED FOR DEFENSE—KEEP IT MOVING!

GRAY IRON FOUNDERS' SOCIETY, INC.

NATIONAL CITY-E. 6th BLDG., CLEVELAND 14, OHIO

Announcing . . . new 148-page Roller Chain Engineering Data Book

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Complete Drives • Transmission Chains
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Please send me a copy of your new 148-page Link-Belt Roller Chain Book No. 2457.

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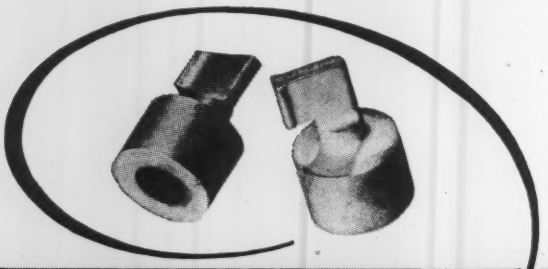
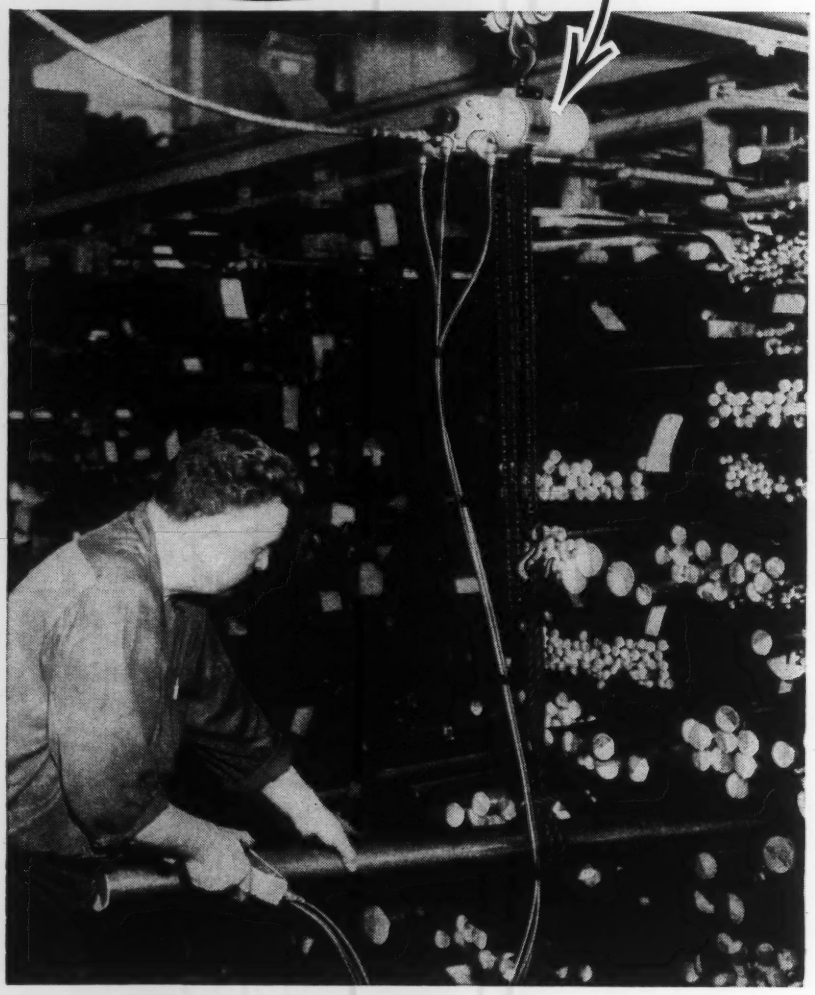


Precision Casting Saves 33%

★



Control fingers for an air hoist are now precision-cast in one piece. Five machining operations are eliminated.

The control finger for this air hoist is stronger and costs one-third less now that it is a HAYNES precision investment casting. The fingers were formerly machined in two pieces and brazed together. The repeated strain of starting and reversing the hoist caused the parts to break at the brazed joint in two to six weeks. No breakage has occurred since changing over to the investment-cast parts.

Precision casting eliminates the brazing operation, because the fingers can be cast in one piece. In addition, several machining operations are no longer necessary—for a saving of 33 per cent.

For tips on designing parts to be produced by precision casting, as well as examples of successful applications, write for the booklet, "Investment Castings."

HAYNES TRADE-MARK *alloys*

Haynes Stellite Company
A Division of
Union Carbide and Carbon Corporation
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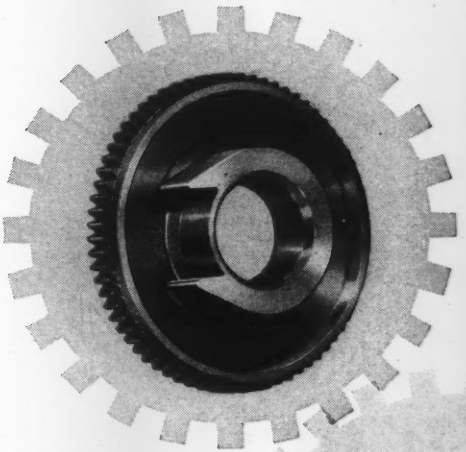
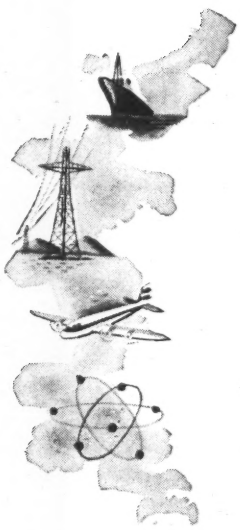
"Haynes" is a trade-mark of Union Carbide and Carbon Corporation.

RYNEL

GEARS *in Fine Pitches*





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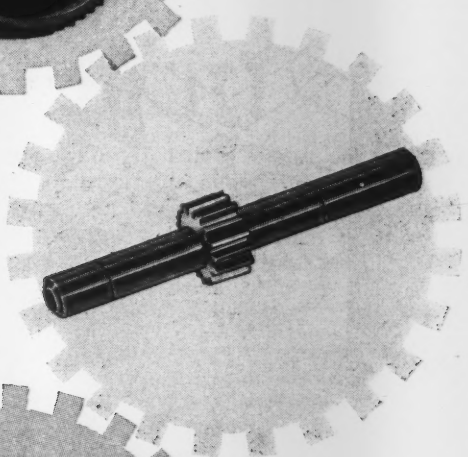
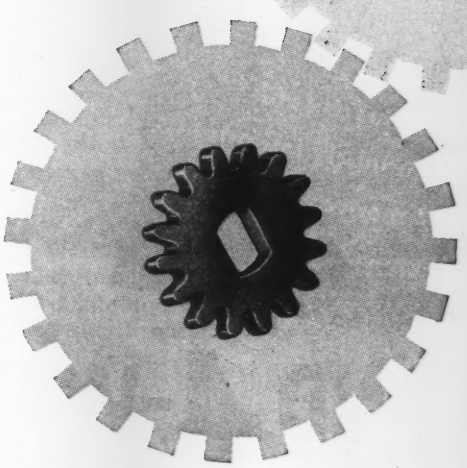
Gear Requirements





Complete Facilities For:

Design Engineering
High Volume Supply
Bar Stock To Finished Gears
Precision Inspection

***RYNEL ENGINEERS** can be in your plant the same day you call.*

Send Blueprints for Quotation,
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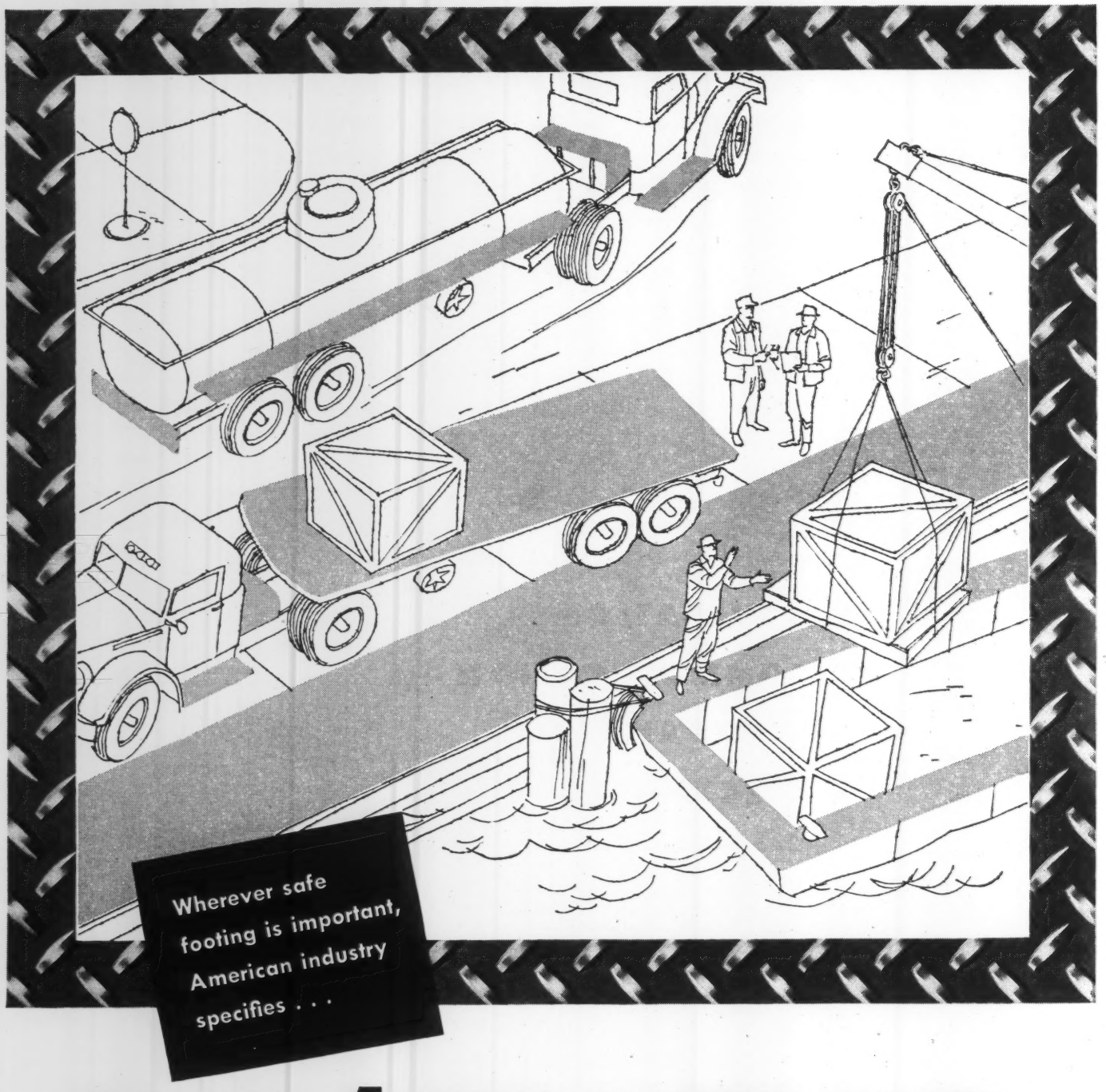
CORPORATION

301 MILLER STREET • STERLING, ILLINOIS

SPUR • HELICAL • WORM • WORM GEAR • INTERNAL SEGMENT • SPROCKET • RATCHET • STRAIGHT BEVEL GEARS



INLAND 4®-WAY SAFETY PLATE

Because ACCIDENTS are COSTLY, safe, sure footing pays off in higher production, better fire protection and lower insurance rates.

Men "on the move" appreciate the non-skid, slip-resistant qualities of Inland 4-Way Safety Plate. They work faster and more efficiently; morale is generally higher.

The long-lasting qualities of Inland 4-Way Safety Plate means lower maintenance and replacement costs —fewer repairs.

You'll be wise to use Inland 4-Way Safety Plate on all danger spots in your plant and as standard equipment for your products. It's a worthwhile investment any way you look at it.

Available from Leading Steel Jobbers

•

WRITE FOR BULLETIN F-1

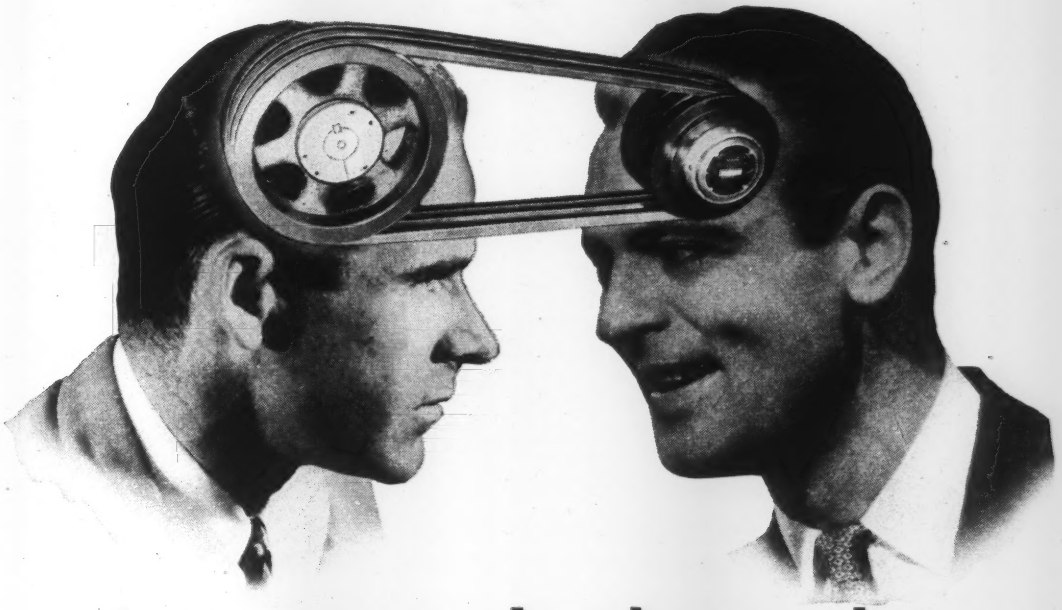
INLAND STEEL COMPANY

38 SOUTH DEARBORN STREET • CHICAGO 3, ILLINOIS

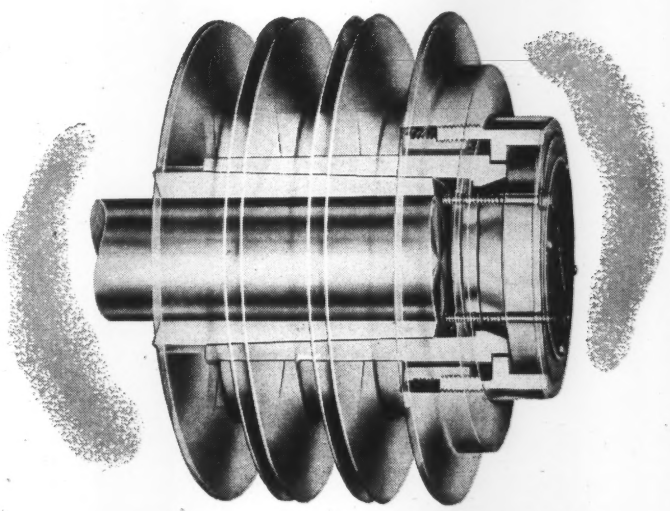
SALES OFFICES: *Chicago • Davenport • Detroit • Indianapolis • Kansas City • Milwaukee • New York St. Louis • St. Paul*

PRODUCTS: *Sheets, Strip, Tin Mill Products, Bars, Plates, Structural Shapes, Sheet Piling, Reinforcing Bars, Pig Iron, Rails and Track Accessories*

INLAND



Let's get our heads together about speed control — and PROFIT!



American Adjustable-Speed Drives are available in A, B, C, Q, and R Section Grooves.

When the competition is tough—there's a lot of profit in that final extra production from every machine in a shop. And that extra production—that touch of gold—is what we'd like to talk over with you.

The American Adjustable-Speed line can add that touch of gold to your production . . . quickly, easily, inexpensively. YOU GET:

• Precision Speed Control • High Production at minimum capital and maintenance cost • Better quality control • Flexibility to meet variations in rated motor speeds or calculated speeds of belt drives

American's exclusive double-taper hub construction maintains speeds at your selected setting and long life of sheave and belts. Sleeves expand to lock flanges in position and the sheave to the shaft during operation . . . there's no chance for wear. Installation or removal is no problem . . . tapered bushings make American Adjustable-Speed Sheaves easy on and easy off the shaft.

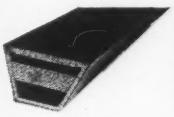
Get the profit story of the American Adjustable-Speed line and see how it can help you to more profit. You're not obligated when you clip and mail the coupon today.

Other Products

Speed Reducers and Overload Releases

Econ-O-Matic Motor Bases

Multiple-Groove Wedg-Tite Sheaves



Wedgbelts

Steel Split Pulleys

Hi-Torque Motor Pulleys

Conveyor Pulleys

Backstops

At the profit end of the machine

Power Transmission by

AMERICAN

PULLEY COMPANY

THE AMERICAN PULLEY COMPANY
4236 Wissahickon Ave., Philadelphia 29, Pa.

Gentlemen:

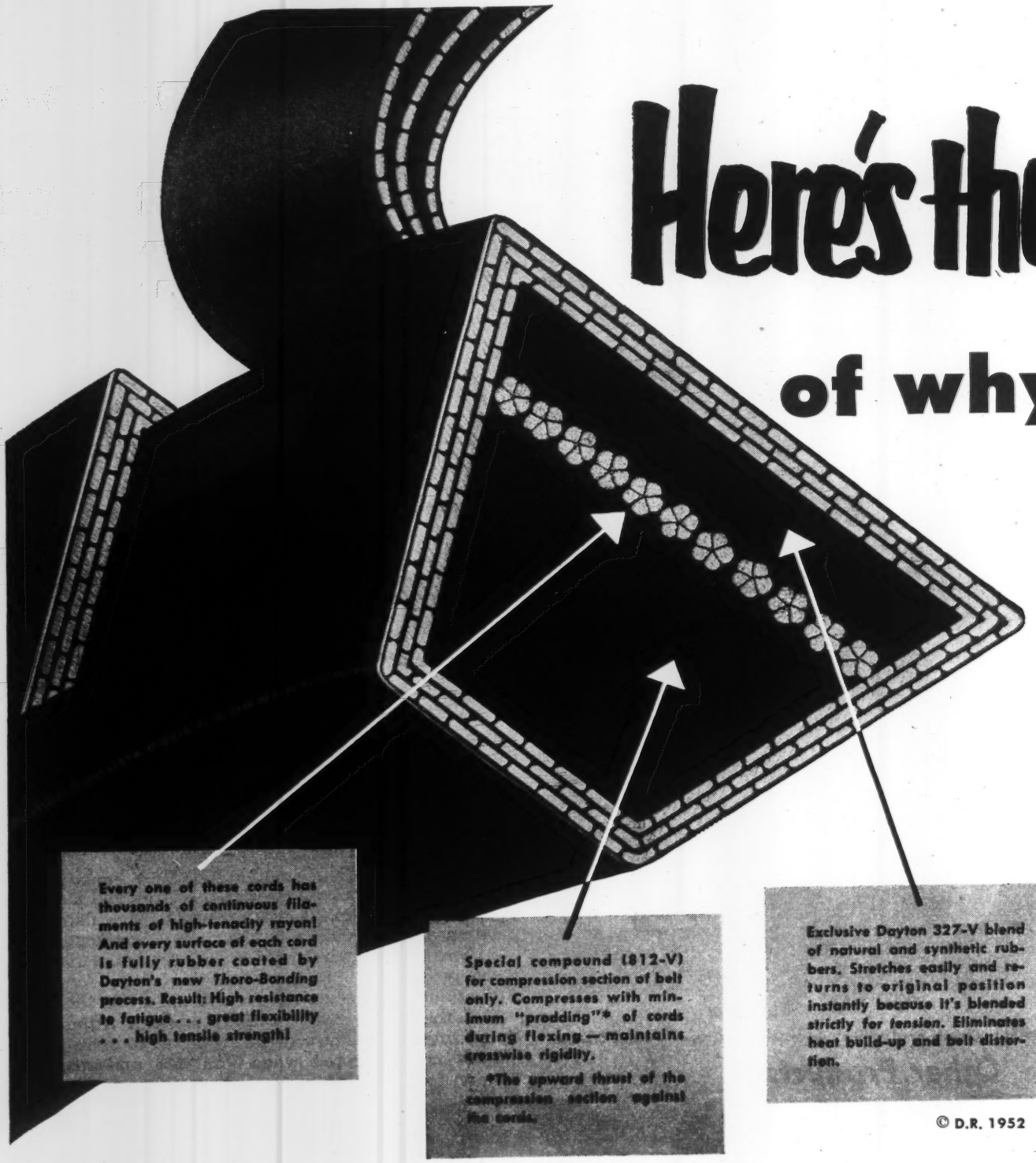
Please rush me your bulletin on the American Adjustable-Speed line.

*Name*_____

*Address*_____

*City*_____ *Zone*____ *State*_____

Here's the of why



Every one of these cords has thousands of continuous filaments of high-tenacity rayon! And every surface of each cord is fully rubber coated by Dayton's new *Thoro-Bonding* process. Result: High resistance to fatigue . . . great flexibility . . . high tensile strength!

Special compound (812-V) for compression section of belt only. Compresses with minimum "prodding"* of cords during flexing — maintains crosswise rigidity.

*The upward thrust of the compression section against the cords.

Exclusive Dayton 327-V blend of natural and synthetic rubbers. Stretches easily and returns to original position instantly because it's blended strictly for *tension*. Eliminates heat build-up and belt distortion.

© D.R. 1952

"I'm Thorobred"

—for typical drives, over normal pulley diameters.

The Dayton "Twins" cut V-Belt Costs

"I'm Cog"*

—for tough drives . . . 40% more horsepower per belt . . . shorter center distances . . . smaller pulleys . . . resists oil, heat and static.

*T.M.

V-Belts

Inside Story★

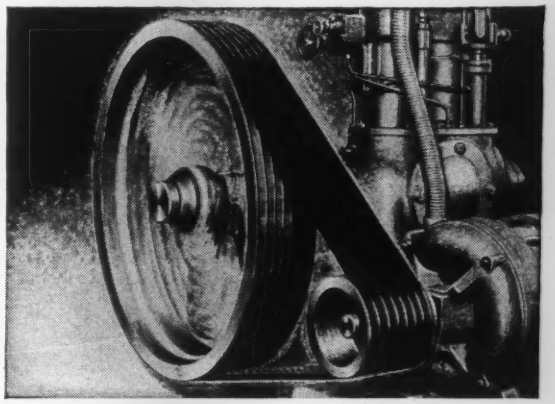
Dayton V-Belts set new performance records!

What kind of suit do you buy—when you want it to wear and wear? A "blue serge" of course. Because it has a high twist weave that's hard and tough. It may get shiny, but it *lasts*. That's why Dayton uses a specially woven "Hi-Twist" fabric to cover the Thorobred V-Belt.

Dayton's "Hi-Twist" fabric *costs more* and is the *finest cover fabric* available today for V-Belts. The extra high twist enables the cover to flex more easily, and gives it a longer, better-wearing life. And to make sure that the cover has the best possible flexing ability, Dayton makes certain that the correct bias-angle in the fabric is maintained at all times.

This "Hi-Twist" cover, exclusive with Dayton, is just *one* of the reasons you design extra belt life into your drives when you specify Thorobreds!

HOW LONG DO DAYTON V-BELTS LAST?



It depends on the drive, of course. But on *this* compressor drive, subjected to heavy shock starting loads, Daytons operated for *20 years!*

★ Get the *complete* engineering story on Dayton V-Belts before you design your next drive! Send for Dayton's 384-page design guide and catalog, with complete engineering data, specifications and design information. And call on our engineering staff for help with your power transmission problems. No obligation, of course. Dayton Rubber Company, Dayton 1, Ohio.

by Dayton Rubber

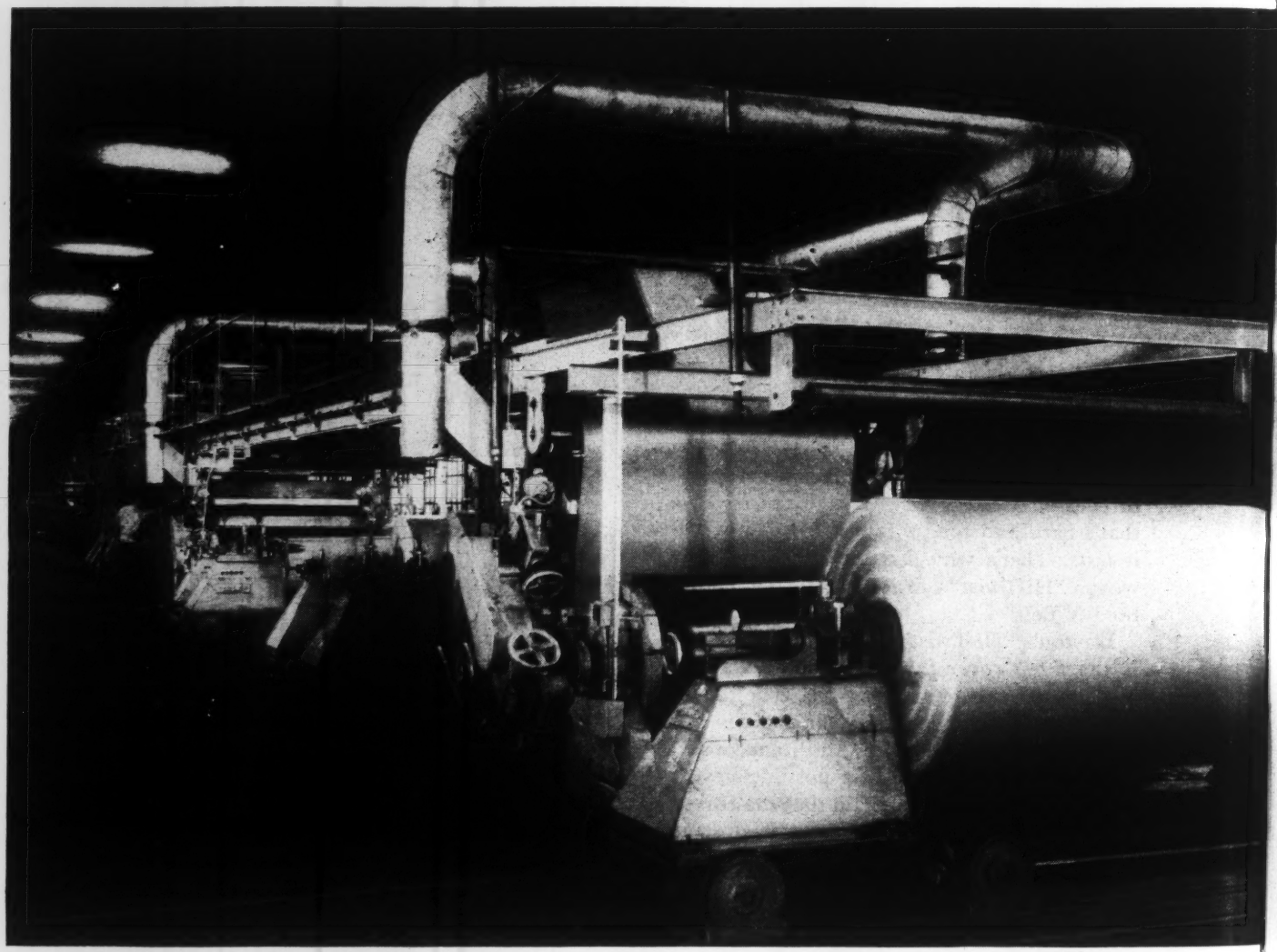
Since 1905

World's Largest Manufacturer of V-Belts

DAYTON RUBBER COMPANY, DAYTON 1, OHIO

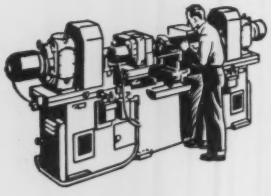
LINK-BELT ball and roller

. . . keep company with America's hardest-



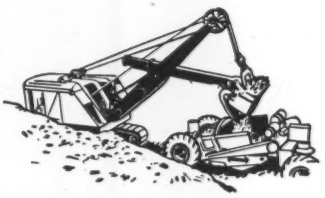
The bearings for this Swift Single and Double-Facing Corrugating Machine, in operation at Connelly Containers, Philadelphia, must meet such varied conditions as heavy pressures, high temperatures and close precision. Over 60 Link-Belt Bearings of various types and sizes are used.

LINK-BELT ball and roller bearings

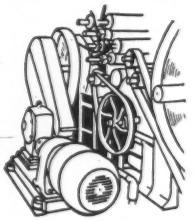


Metal Working Machinery

Farm Machinery



Construction Equipment



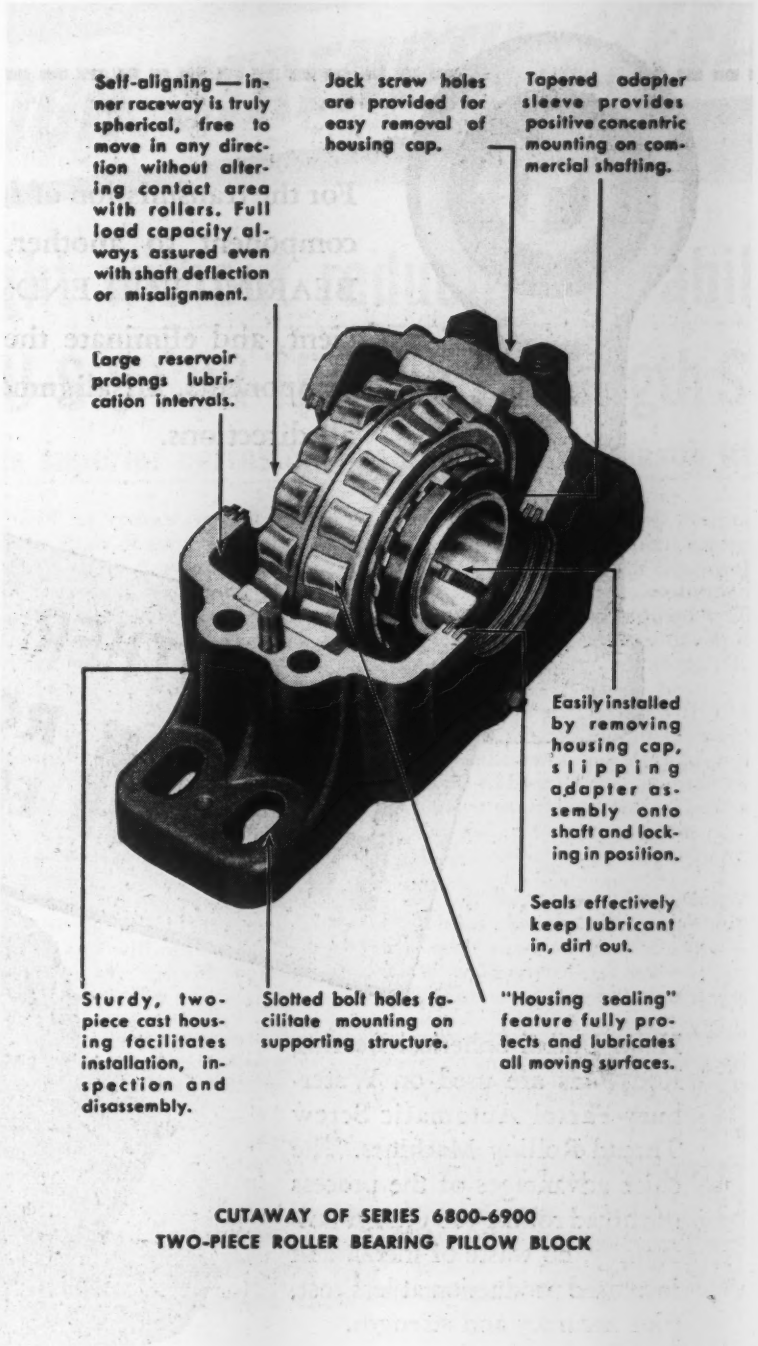
Textile Machines

bearings
working machines

YOU can always rely on Link-Belt Ball and Roller Bearings. Built to the highest standards of modern precision manufacture, they assure long-life, free-rolling shaft support — even with shaft deflection or misalignment.

And you can get a size and type to match your exact bearing requirements. Link-Belt builds a complete line of industrial mounting designs—pillow blocks, flanged, flanged cartridge, cartridge, hanger and take-up blocks — in addition to unmounted bearings.

For application information, get in touch with a Link-Belt bearing engineer. Complete engineering data is also available in Book 2550.



CUTAWAY OF SERIES 6800-6900
TWO-PIECE ROLLER BEARING PILLOW BLOCK

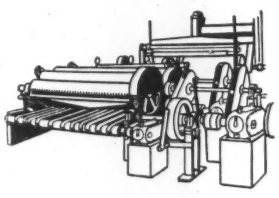
LINK-BELT

BALL and ROLLER BEARINGS

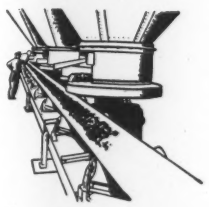
LINK-BELT COMPANY: Indianapolis 6, Chicago 9, Philadelphia 40, Atlanta, Houston 1, Minneapolis 5, San Francisco 24, Los Angeles 33, Seattle 4, Toronto 8, Springs (South Africa), Sydney (Australia). Offices, Factory Branch Stores and Distributors in Principal Cities.

12.889

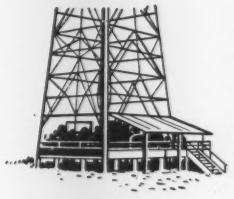
smooth the path of power for all industry



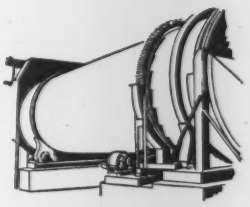
Pulp & Paper Machinery



Materials Handling Equipment



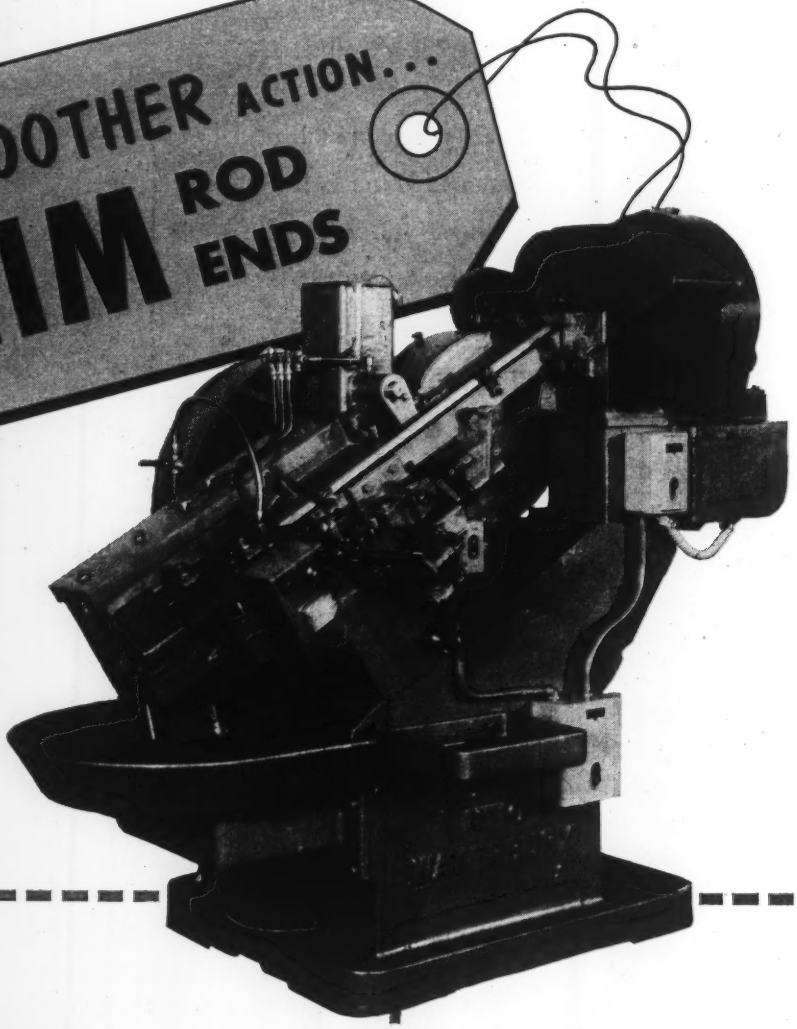
Oil Field Equipment



Processing Equipment

For the transmission of force and motion from one machine component to another, HEIM UNIBAL SPHERICAL BEARING ROD ENDS are more dependable, more efficient, and eliminate the necessity for specially machined components. Misalignment of stud or shaft is corrected in all directions.

FOR SMOOTHER ACTION... HEIM ROD ENDS



Heim Unibal Spherical Bearing Rod Ends are used on Waterbury-Farrel Automatic Screw Thread Rolling Machines. The chief advantages of the process of thread rolling are greater uniformity, no waste of metal, and increased production at less cost, plus accuracy and strength.

THE HEIM COMPANY

WRITE FOR COMPLETE INFORMATION AND CATALOG

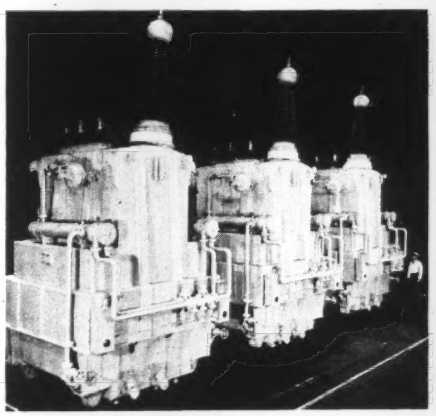
FAIRFIELD, CONNECTICUT

Facts you should know about U·S·S HIGH STRENGTH STEELS

You can reduce weight without reducing durability

with U·S·S COR-TEN High Strength Steel

—its superior corrosion resistance is the reason why



U·S·S COR-TEN steel saves 9 tons of steel in these transformer shells. Lighter weight makes installation easier—saves $642 in shipping costs—steel supply goes 33% further.

By using 3/8" U·S·S Cor-Ten steel plates in place of 1/2" mild steel in the shells of three 29,000 kva, 230,000 volt transformers, the Pennsylvania Transformer Company, Canonsburg, Pa., reduced weight per unit from 24,000 lbs. to 18,000 lbs. This 3-ton weight saving not only conserves steel, and makes the transformers easier to install, but cuts the costs of shipping to their destination in Oregon, $214 per unit.

Here's what Pennsylvania Transformer has to say about this application. "With the trend to larger generating stations, the ability of the utilities to handle the physical size and weight of transformers has been of growing concern. Weight of the finished transformer is therefore important.

"The corrosion question is always pertinent. If the generating plant is hydro, you may have water spray to contend with. If it is steam generated by coal, you have an atmospheric problem. Corrosion-resistant steel, therefore, is desirable.

"By substituting U·S·S Cor-Ten steel on these new transformers we obtained both weight reduction and corrosion resistance. In our opinion, Cor-Ten steel has far more resistance to atmospheric corrosion than copper bearing steel, and with it our engineers were able to reduce weight to such a degree that the extra cost for Cor-Ten steel was more than offset by (1) less tons used, and (2) freight reduction on the finished product.

"Our shop people tell us it is a bit more difficult to bend in the brake press but, once formed, U·S·S Cor-Ten steel stays in position better than mild steel, making it easier for our fitters to put the transformer tanks together."

Any steel used to reduce weight needs more than high strength alone. To meet the test of time, it must have high resistance to corrosion as well. Superior ability to fight corrosion is the important property that sets U·S·S Cor-Ten steel apart from most other high strength steels.

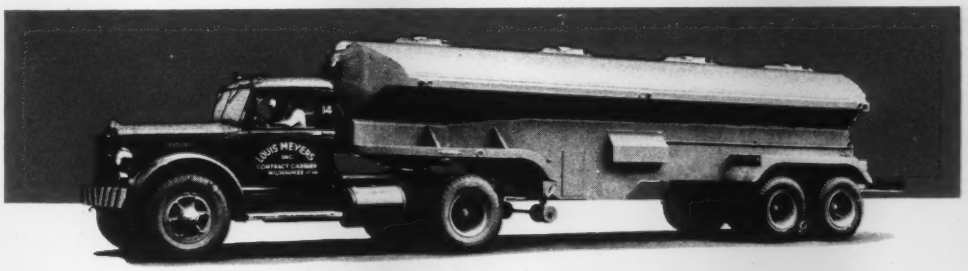
For not only does this pioneer low-alloy, high-strength steel have a yield point nearly twice that of structural carbon steel, but in addition, Cor-Ten steel's *resistance to atmospheric corrosion is from 4 to 6 times greater.*

As a result, U·S·S Cor-Ten steel can be safely used in thinner sections to substantially reduce weight, and because its strength is strongly protected against corrosive attack, this lighter construction will last just as long and will require no more maintenance than the heavier construction it replaces.

For the past 17 years, designers have used U·S·S Cor-Ten high strength steel to lift the costly drag of deadweight from every kind of mobile equipment—from freight cars and streamlined trains, from buses, trucks and trailers. Even shop pallets, tote boxes, refrigerators, filing cabinets and baby walkers have been built lighter and longer lasting with U·S·S Cor-Ten steel. Every pound of weight saved in this equipment has meant fewer pounds of metal to buy—fewer pounds to move—and fewer pounds to ship. That makes for SAVINGS, all along the line.

• • •

If you want to reduce weight safely, with least change in shop methods, and at low cost, send us your designs and we'll show you where and how to use U·S·S Cor-Ten steel to best advantage.



Built 1,150 lbs. lighter with U·S·S COR-TEN steel this bulk cementer carries 3 barrels free on every trip

● Weight reduction pays off in this modern 120-bbl. capacity cement hauling unit. The more than one-half ton of weight saved by Cor-Ten steel construction is replaced by three barrels of payload that ride cost free, which saves the carrier $1.26 on every 100-mile round-trip the unit makes. It totals up to a tidy sum as the years roll by.

Built by the Trailmobile Co., Cincinnati, Ohio, the hopper body has V-type quick discharging bottom. U·S·S Cor-Ten steel, used one to two gages lighter than would be necessary with carbon steel, reduces the weight from 13,970 lbs. to 12,820 lbs.

U·S·S Cor-Ten steel construction does more than save weight and reduce delivery costs. It gives this Trailmobile carrier body 4 to 6 times higher resistance to atmospheric corrosion than plain steel. It insures superior resistance to wear and abrasion—materially increases ability to withstand road shock and vibration.

Since its introduction seventeen years ago, U·S·S Cor-Ten steel has been used by 27 leading builders of trucks and trailers—names famous in the commercial car industry—to make their equipment lighter, more durable, able to carry more payload, and cheaper to operate and maintain.

UNITED STATES STEEL COMPANY, PITTSBURGH • AMERICAN STEEL & WIRE DIVISION, CLEVELAND • COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH • TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. • UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

USS

Facts you should know about U·S·S CARILLOY STEELS

U·S·S metallurgists can help you turn out quality products with lean alloy steels

● Thousands of manufacturers have lately been forced into using lean alloy steels, instead of the rich alloys they are accustomed to. Some have found that the transition from rich to lean alloy has presented a few problems. However, satisfactory results *can* be obtained from lean alloy steels, if heat-treating and fabricating methods are adjusted to suit these steels.

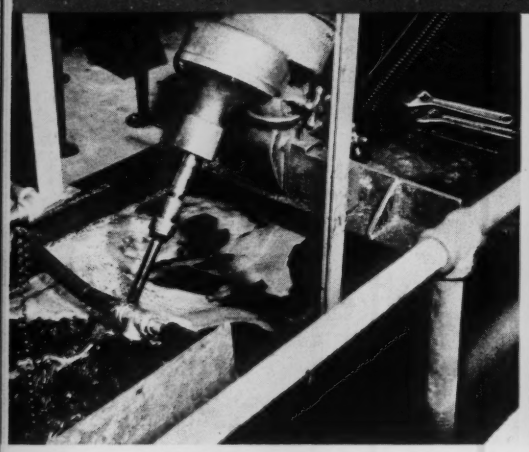
If you are having trouble perhaps we can help you. We'll be glad to analyze your heat-treating and fabricating methods and give you specific advice based on our wide experience in this field.

There is no charge for this service. It's part of our continuing program to help all of our customers get the most out of the steels they're using.

We quote two well-known manufacturers who have benefited from our suggestions:

"Results with lean alloys equal to those with high alloys"

—UTICA DROP FORGE & TOOL CORPORATION



"... with improved quenching ... we obtain more satisfactory hardening."

"Forging is easier with lean alloys."

● Utica Drop Forge & Tool Corporation developed an improved method of quenching and tempering with the help of U·S·S metallurgical assistance. Mr. C. E. Wilderman, Vice President of the Tool Division, has this to say: "With your help, our metallurgists have developed heat-treating methods that enable us to get results with lean alloys equal to those obtainable with high alloys. Daily control tests show that our adjustable-end wrenches surpass the Federal Specifications by several times (for the 12-inch wrench—25,000 in. lbs. of torque as compared to 7,650 in. lbs. required). We know a good deal of the credit for these high torque ratings is due to the improved heat treatment."

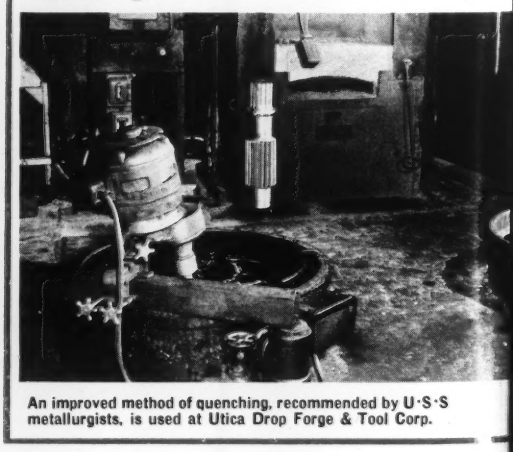
"Improved quenching... Increased production..."

—JEFFREY MANUFACTURING COMPANY

● Mr. C. S. Thomas, Chief Metallurgist at Jeffrey Manufacturing Company, says, "We used to have trouble with uneven hardening.

"Now, with an improved quenching process recommended by U·S·S engineers, we get uniform hardness without exception. The new method speeds up quenching and makes it easier to quench large parts, such as 100-pound, alloy steel gears.

"We gain increased production and reduce the chance for human error. In addition, we obtain more satisfactory hardening."



An improved method of quenching, recommended by U·S·S metallurgists, is used at Utica Drop Forge & Tool Corp.

Our engineers and metallurgists will bring to the solution of your problems the latest ideas and techniques in the working and treating of steel. We urge you to draw freely on their services. Just call your nearest District Sales Office, or write to United States Steel Company, 525 William Penn Place, Pittsburgh 30, Pa.

UNITED STATES STEEL COMPANY, PITTSBURGH COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

USS

UNITED STATES STEEL

Facts you should know about

U·S·S CARILLOY STEELS

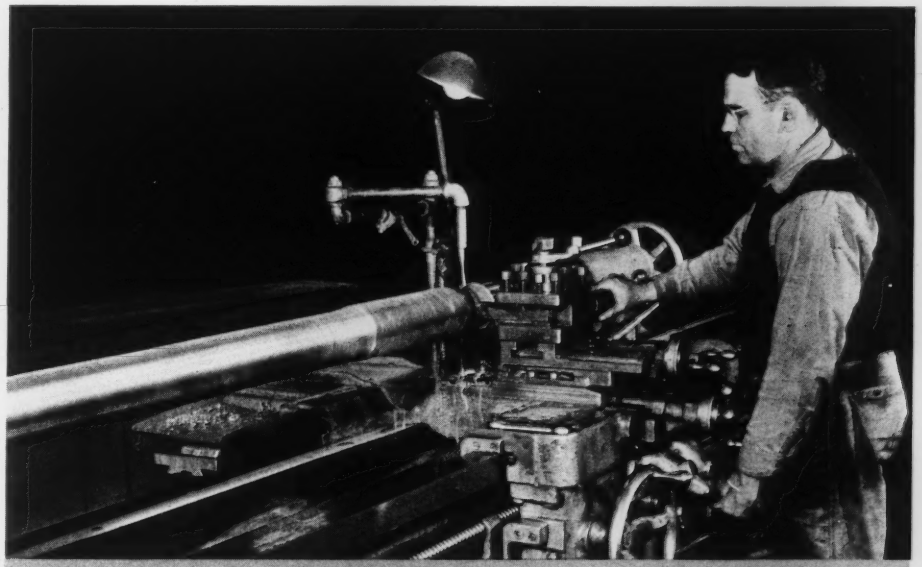
Heavy-duty axles and shafts made without heat treating—with pre-hardened free-cutting CARILLOY FC

● Every year, over 5 million tons of coal pour out of the 6 Fairmont, West Virginia region mines of Consolidation Coal Company (W. Va.). All repair and rebuilding of the hard-working equipment used in these mines are done at the company's Monongah, W. Va., maintenance shop.

Here, highly skilled machinists make everything from mine locomotive axles to armature shafts. Each new part they make must be as strong as the original, without benefit of heat treatment after machining.

So here is just the place for a very special kind of alloy steel.

Consolidation Coal Company (W.Va.) has found that they can produce practically all of the heavily stressed parts they use in their own shops—without heat treating—with a special grade of alloy steel, such as U·S·S CARILLOY FC steel. This pre-hardened, free-cutting alloy steel is received from the mill already quenched and tempered to the hardness required. No further heat treatment is necessary. Finished parts have a minimum tensile strength of 140,000 psi. and good surface finish.



HERE, in the Monongah, W. Va., maintenance shop of Consolidation Coal Company (W. Va.), a machinist turns a CARILLOY FC axle for a 20-ton locomotive.

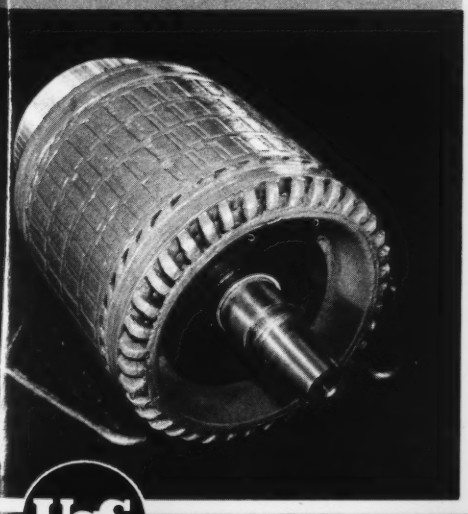
U·S·S CARILLOY FC offers you important advantages if you have to make heavy-duty shafting or other parts that require 125,000 to 175,000 psi. steel. This deep-hardening manganese, chromium, molybdenum alloy steel is available quenched and tempered from 255 to 375 Brinell. You don't have the expense of heat treating after machining and you eliminate rejects caused by distortion and scaling.

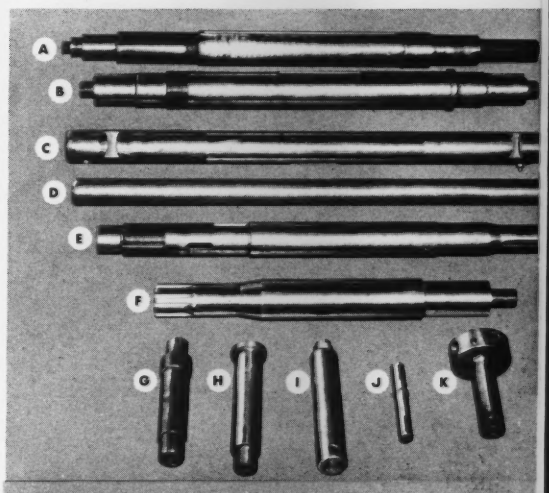
For *production* work, remember that CARILLOY FC, easy to machine, is easy on your tools—some users report that tools last 300% longer, and more pieces can be produced per hour.

CARILLOY FC is available now, quenched and tempered *or* annealed, in all standard bar forms and sizes.

It costs only a fraction of a cent more per pound than ordinary through-hardening alloy steels.

The shaft for this 1800 pound locomotive armature was machined from CARILLOY FC.





CARILLOY FC is used in machining this great variety of parts. Notice the diversity of applications handled by one grade of alloy steel: (A) is an armature shaft. The following parts are for loading machine: (B) loading clutch shaft, (C) conveyor take-up shaft, (D) conveyor hinge pin, (E) transmission clutch shaft, (F) caterpillar drive axle, (G) caterpillar idler axle, (H) sprocket shaft, (I) caterpillar take-up shaft, (J) hydraulic pump shaft, (K) caterpillar take-up screw.

USS

UNITED STATES STEEL COMPANY, PITTSBURGH · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

Facts you should know about U·S·S STAINLESS STEEL

U·S·S 17 (Type 430) finding wide acceptance

both as an alternate grade and for new Stainless applications

THE ready availability of straight-chromium Stainless Steels has led designers to take a closer look at these materials. As a result, they are discovering hitherto unexplored and highly-desirable qualities both in fabrication and performance.

For example, the lower tensile strength of the straight-chromium grades enables them to be drawn, bent or sheared with less power than comparable nickel-bearing grades. Spinning is easy and welding presents no unusual difficulties.

These qualities have led designers to specify the straight-chromium grades, including U·S·S 17 (Type 430) Stainless Steel, not only as alternates for currently unavailable nickel-bearing grades but also in applications where Stainless Steel has not been used previously.

Since straight-chromium Stainless Steel has been available without CMP tickets in recent months, these designers have investigated it for applications where even carbon steel has been used before. And they have found the superior corrosion resistance, the attractive appearance and the ease of cleaning of U·S·S 17 far more than offset its additional cost.

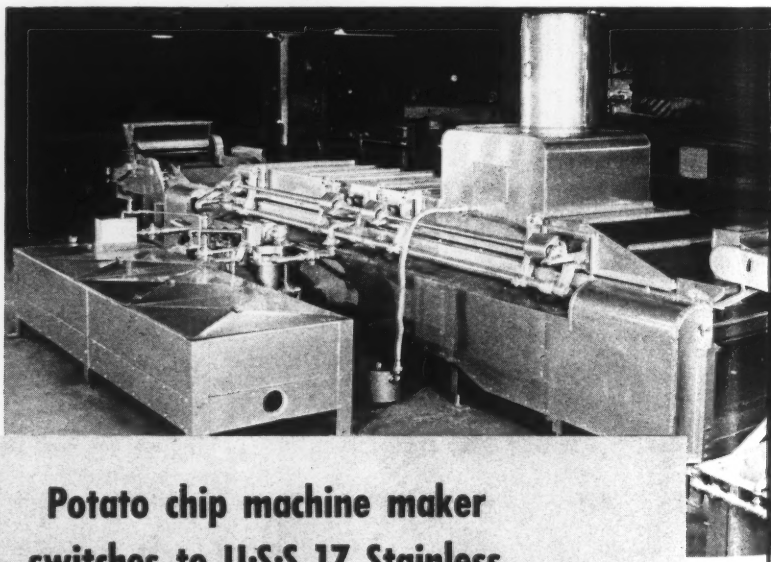
As an alternate for nickel-bearing grades, U·S·S 17 Stainless has taken its place on the production line of many products. Many manufacturers report no problems encountered in the switch; in some instances shop employees had to be told they were using a different grade.

Whether you are considering U·S·S 17 as an alternate grade or for a first use of Stainless, our engineers will be glad to assist and advise you in its application.

Icing depositor now manufactured from U·S·S 17 Stainless Steel

Mallet & Company, Pittsburgh, Pa., manufacturer of equipment for the baking industry, turned to U·S·S 17 Stainless for their icing depositor. This grade fulfills every requirement of sanitation, appearance, ease of cleaning and durability.

Fabrication of the outer shell, drawer, fixtures, top, hopper, drive cover, shaft and agitator from U·S·S 17 involved no problems. Steps involved include bending, roll forming and welding.



Potato chip machine maker switches to U·S·S 17 Stainless

Restrictions on nickel-bearing grades of Stainless Steel led J. D. Ferry Co., Inc., Harrisburg, Pa., to examine U·S·S 17 for suitability in manufacture of its potato chip machines. As a result, supply tank covers, side panels, salter, chip chute, vapor vent stack and washing machine cover of the machine are fabricated from this straight-chromium grade.

Fabrication, including brake forming of ⅜" Stainless plate, riveting, stamping, roll forming and welding, caused no difficulty. The appearance and ease of cleaning of U·S·S 17 meet the company's rigid specifications.

U·S·S STAINLESS STEEL SHEETS · STRIP · PLATES
BARS · BILLETS · PIPE · TUBES · WIRE · SPECIAL SECTIONS

UNITED STATES STEEL COMPANY, PITTSBURGH · AMERICAN STEEL & WIRE DIVISION, CLEVELAND · COLUMBIA-GENEVA STEEL DIVISION, SAN FRANCISCO
NATIONAL TUBE DIVISION, PITTSBURGH · TENNESSEE COAL & IRON DIVISION, FAIRFIELD, ALA. · UNITED STATES STEEL SUPPLY DIVISION, WAREHOUSE DISTRIBUTORS
UNITED STATES STEEL EXPORT COMPANY, NEW YORK

UNITED STATES STEEL

NEW! the COPYFLEX "30"

High Speed
Low Price
Premium Prints

Here, for the first time, is a copying machine — Bruning's remarkable Model "30" COPYFLEX — that combines such a relatively *high speed* with such a *low price* and such *premium quality,* ready-to-use prints.

The "30" is ideal for the drafting room or office with medium volume requirements and a moderate budget. It handles cut sheets or roll stock up to 42 inches wide, and offers features ordinarily found only in larger, more expensive machines.

With the "30" and the unsurpassed line of sensitized COPYFLEX papers, cloths and films, you can always get the kind of premium prints you want, when you want them.

Why wait on inadequate equipment or for "outside" copying? See how the COPYFLEX "30" can save your time, cut your costs. Just send in the coupon *now!*

Only *COPYFLEX* gives you all these advantages!

- Premium quality prints ready for immediate use
- No installation — simply make an electrical connection
- No fumes or exhausts because it uses no vapor developer
- Unexcelled range of sensitized papers, cloths and films
- Anyone can operate a COPYFLEX machine with a simple 5-minute explanation

MODEL "93"—finest of copying machines. There's a COPYFLEX machine that's just right for every price and volume requirement.

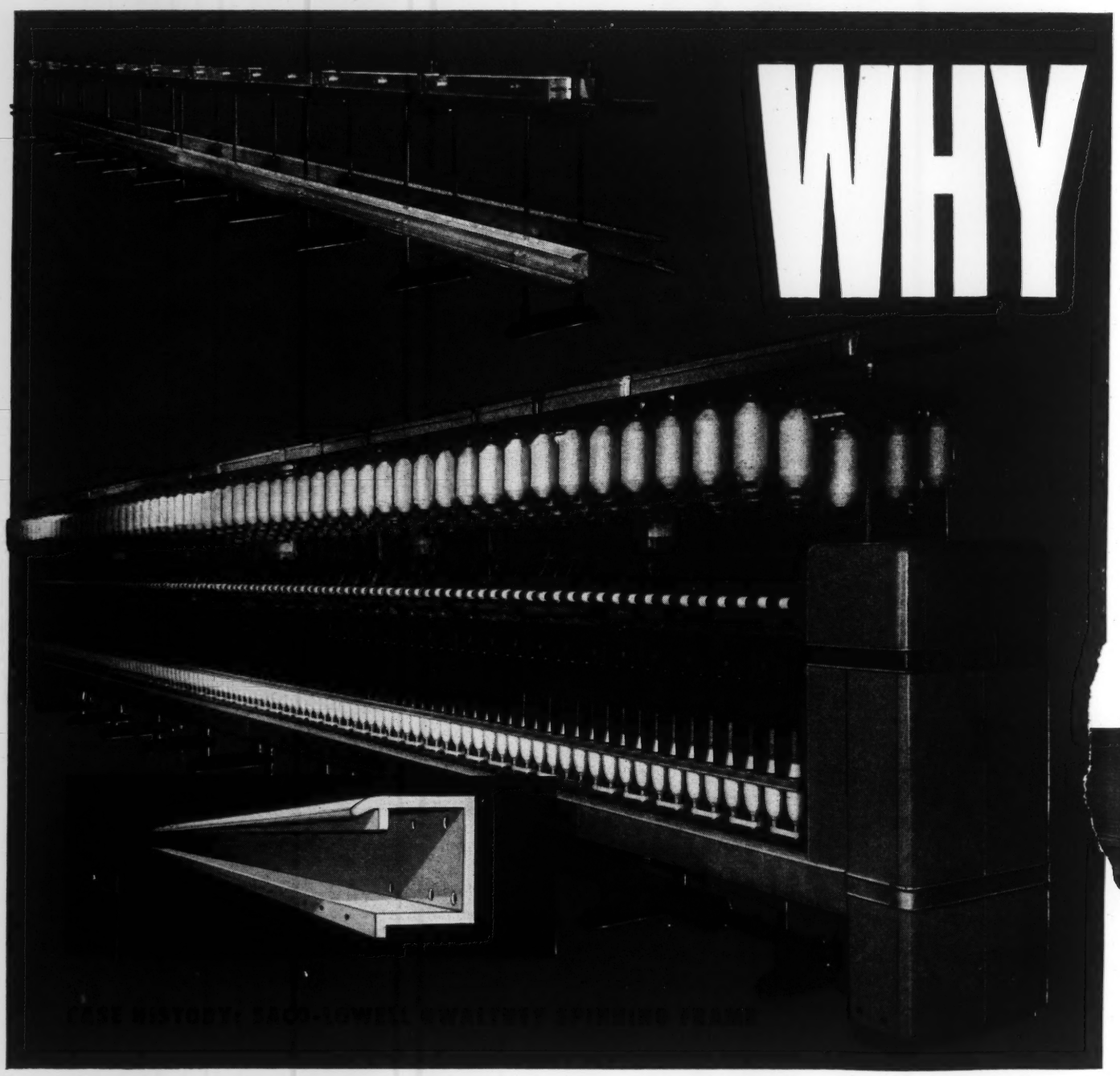
BRUNING

Specialists in copying since 1897

CHARLES BRUNING CO., INC.
Dept. G62 Teterboro, New Jersey

☐ Send me free booklet on COPYFLEX "30."
☐ Show me COPYFLEX in action (no obligation).

Name ..... Title .....
Company .....
Street .....
City ..... Zone ..... State .....



Superior speed, efficiency and economy are prime features of the new Gwaltney—the radically different spinning frame that combines the many advantages of strong, light weight aluminum with seven years of careful planning by the Saco-Lowell Shops, Biddeford, Maine.

Approximately 1500 pounds of aluminum is used in this advanced spinning frame . . . nearly 800 pounds of extrusions, 500 pounds of die castings, 200 pounds of sheet. The spindle rails, made of aluminum extrusions weighing over 525 pounds, are typical of the many places where aluminum effectively replaces parts formerly made of other metals. These rails, along with other key parts, are more easily and quickly manufactured thanks to the flexibility that aluminum provides in fabricating methods.

Aluminum's light weight pays off, too, in the new Gwaltney Spinning Frame. Floor loads are reduced and light aluminum ring rails give power savings and smoother reciprocating motion. Aluminum sheet cover plates provide completely closed box sections for greater rigidity and minimum vibration. Aluminum parts can't rust, can't stain fibers.

Progressive thinking may call for consideration of aluminum in your operations because whether you're concerned with zippers or spinning frames, door hinges or trailer bodies—chances are aluminum can speed production, increase capacity and lower costs for you!

LET ALUMINUM SERVE YOU, TOO

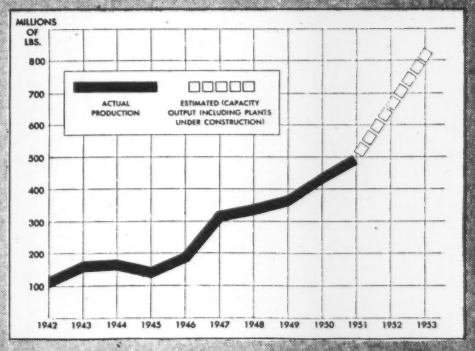
ALUMINUM?

...because it has an ideal combination of advantages found in no other metals!

More aluminum is being specified in designs today because aluminum improves products and increases sales. Let Reynolds Aluminum Specialists help your designers and engineers get maximum benefits from this modern metal. Remember, only aluminum gives you . . .

- ★ **Lightweight with great strength**
- ★ **Consistently low cost**
  (now less than before World War II)
- ★ **Natural resistance to rust and corrosion**
- ★ **Ease of fabrication by modern methods**

STILL MORE ALUMINUM COMING



The expanding primary aluminum production of Reynolds Metals Company . . . a historic chapter in the company's 33 years of continuing growth. And primary supplies of aluminum ore are ample for generations.

To the man in charge of production

Acquaint yourself with accepted techniques for fabricating aluminum. Write on your letterhead for aluminum fabrication books listed at right. On special problems consult with Reynolds staff of aluminum specialists. Reynolds Metals Company, 2521 South Third Street, Louisville 1, Kentucky.

Yours For The Asking . . .
REYNOLDS TECHNICAL BOOKS

(please request on business letterhead)

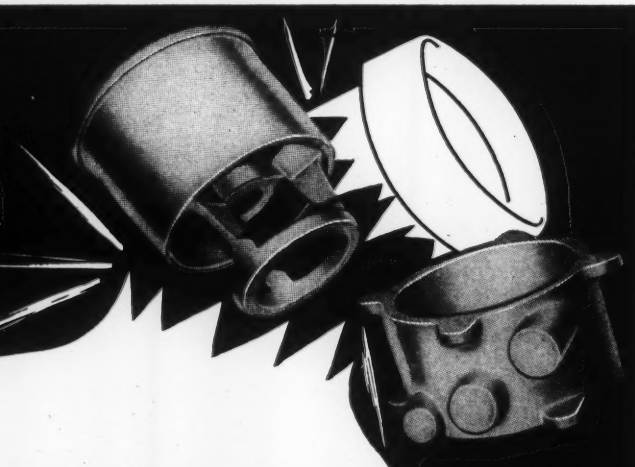
- A-B-C's of Aluminum
  (from mine to finished products)
- Aluminum Data Book
  (Aluminum Alloys and Mill Products)
- Aluminum Structural Design
- Designing with Aluminum Extrusions
- Fastening Methods for Aluminum
- Finishes for Aluminum
- Forming Aluminum
- Welding Aluminum
- Machining Aluminum Alloys
- Heat Treating Aluminum Alloys
- Metals Weight Slide Rule

Complete index of all technical literature and films on aluminum design and fabrication also available.

REYNOLDS ALUMINUM

REYNOLDS METALS

Break YOUR PRODUCTION Bottleneck WITH PERMITE ALUMINUM CASTINGS



WE CAN FILL YOUR ORDER FOR ALUMINUM CASTINGS

✓ any size
✓ any type
✓ any quantity
. . . and do it FAST!

If you're facing a production bottleneck because you can't get parts or materials, check to see if the part that's holding you up can be made of aluminum alloy. If it can be cast in aluminum, YOU NO LONGER HAVE A BOTTLENECK because we can supply whatever you need in any size, and any quantity, as fast as you need it.

If you don't know whether aluminum castings could be the answer to your problem, send us your blueprints, and we'll tell you whether or not we can help you, and how much it will cost.

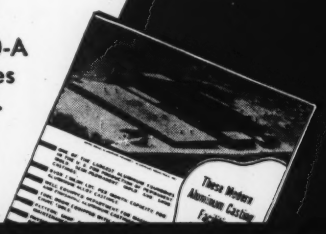
Aluminum Industries, Inc., has one of the largest aluminum foundries in the United States for the production of Permanent Mold, Semi-Permanent Mold and Sand Castings.

Our Engineering Department is equipped to handle any problem from initial design through to the finished casting.

Our foundry personnel functions with all the skill and "know-how" of over 30 years of experience in working with aluminum and its alloys.

Our warehousing facilities are ample, and shipping rates from centrally located Cincinnati are favorable.

Send blueprints for recommendations and estimate without obligation.



Our Bulletin No. 20-A completely describes our facilities in detail. Free copy on request.

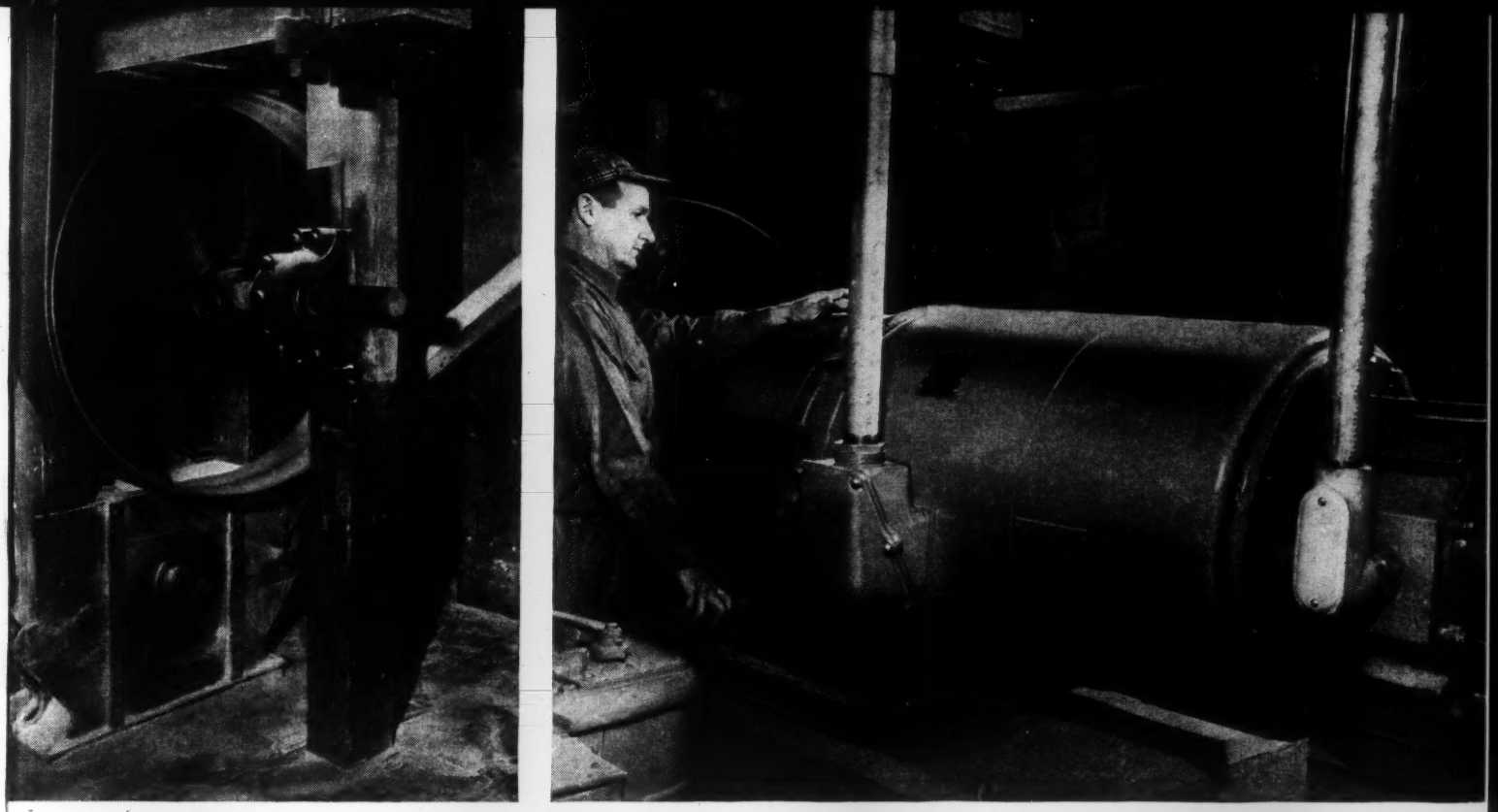
PERMITE

ALUMINUM INDUSTRIES, INC.

CINCINNATI 25, OHIO

DETROIT: 809 New Center Building. NEW YORK: 9 Rockefeller Plaza. CHICAGO: 64 E. Jackson Boulevard. ATLANTA: 413 Grant Building.

ALUMINUM PERMANENT MOLD and SAND CASTINGS . . . HARDENED, GROUND and FORGED STEEL PARTS



F. W. Stock & Sons needed a better drive on grinding machines in flour mill. Picture at left shows old drive when shaft was powered by belts from motors and speed reducers that also drove other lines. Instead of another motor and speed reducer for new drive, they switched to a 75-hp G-E gear-motor (right) to gain additional power, modern equipment, savings on initial costs.

Three More Plants Choose G-E Gear-motors

One reports output up 20% at "A" mill; Others compactness, low maintenance

A large, independent flour mill and two prominent machinery builders have been added to the long list of industries profitably using General Electric Gear-motors.

F. W. Stock & Sons, report a production increase of 20% in their "A" mill since a 75-hp G-E Gear-motor was installed to drive flour grinding machines.

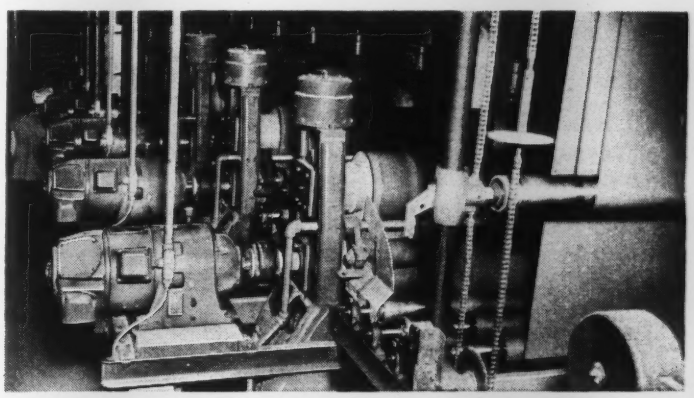
H. W. Butterworth & Sons, textile machinery manufacturer chooses G-E Gear-motors to drive machines requiring a reliable, compact low-speed drive.

F. X. Hooper Co., manufacturer of corrugated fibre box machinery, likes G-E Adjustable-speed Gear-motors because of their flexibility, trouble-free operation.

Throughout all industry, General Electric Gear-motors show "on the job" proof that they are best for most low-speed drives. And *prompt delivery* of Gear-motors is assured through warehouse stocks located in thirty-three key industrial areas. To solve your motor drive problems, contact your nearest G-E office or Distributor. *General Electric Co., Schenectady 5, N. Y.*

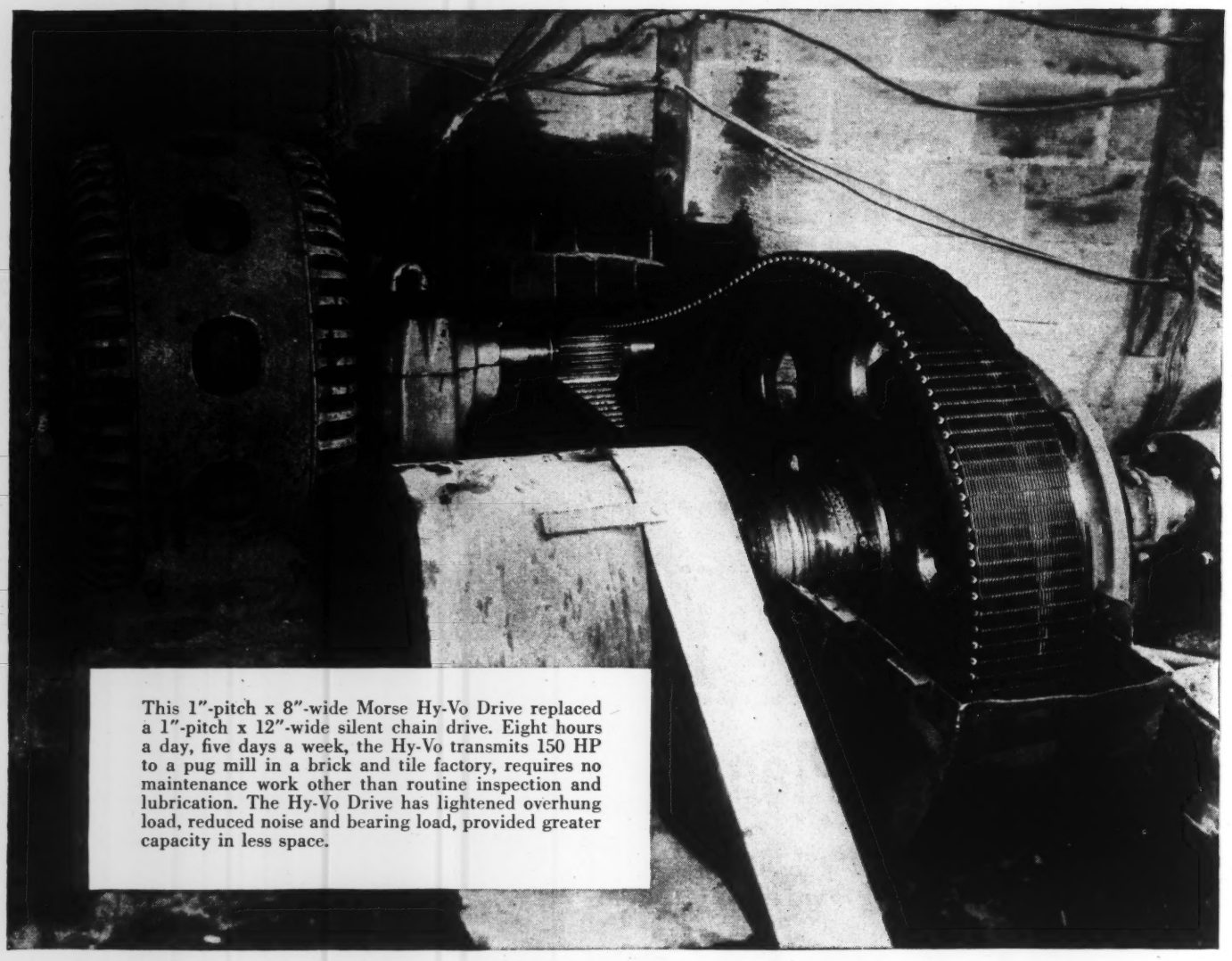
755-8

GENERAL ELECTRIC

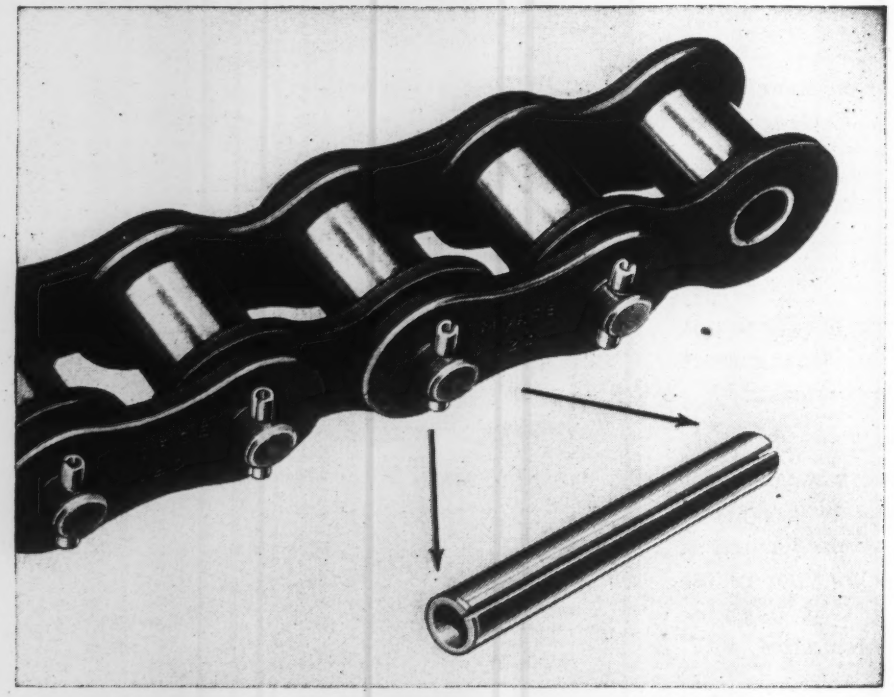


Nine General Electric d-c gear-motors drive Butterworth soaper in Fruit of the Loom textile plant. G-E gear-motors also power agers, padders in this continuous-process finishing range.

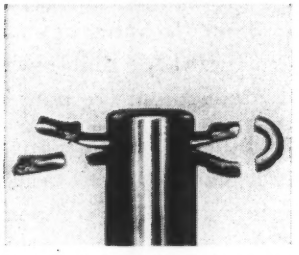
G-E ACA adjustable-speed gear-motors now drive new F. X. Hooper partition slotters. The first installation of this modern equipment was made at a plant of the Owens-Illinois Glass Co. of California.



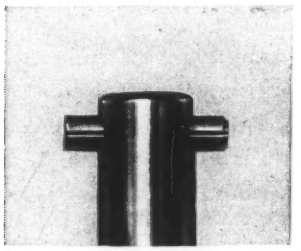
This 1"-pitch x 8"-wide Morse Hy-Vo Drive replaced a 1"-pitch x 12"-wide silent chain drive. Eight hours a day, five days a week, the Hy-Vo transmits 150 HP to a pug mill in a brick and tile factory, requires no maintenance work other than routine inspection and lubrication. The Hy-Vo Drive has lightened overhung load, reduced noise and bearing load, provided greater capacity in less space.



Rollpins outlast standard cotter pins more than ten to one!

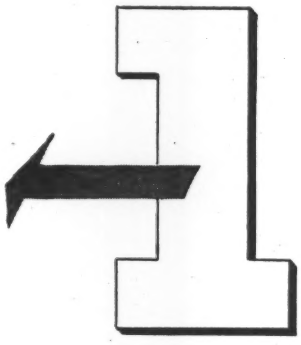


Standard heat-treated cotter pin after only 3 hours on fatigue tester.



Rollpin after 50 hours on fatigue tester. It will outlast any other fastener on the market.

Can either of these recent MORSE advances eliminate a problem for you?



Morse Hy-Vo Drive

You can depend on the sensational Morse Hy-Vo Drive to transmit more horsepower per inch of width than any other drive. But that's only the beginning.

Hy-Vo transmits up to 5000 HP, can operate at speeds of 3600 RPM and linear velocities of 6500 FPM. It cuts operating costs as much as 50%; gives ⅓ longer service life; operates ⅓ cooler than conventional silent chain, with ⅓ less noise. It does away with expensive, space-eating outboard bearings.

In the field of heavy-duty, high-speed power transmission, Morse Hy-Vo Drives open up entirely new design possibilities for you—with special emphasis on space and weight savings, cost savings, and far longer drive life. Write us for Catalog C 72-51.

Morse Roller Chain with new Rollpin fasteners

Now, Morse gives you the most reliable, longest-lived fastener ever incorporated into a power transmission chain.

It's the Rollpin, a chamfered-end, heat-treated, slotted steel cylinder that is compressed into a pin hole smaller than the Rollpin's own diameter. The Rollpin expands and locks into place until deliberately removed by hammer and punch. It can't fatigue out.

At no price increase, Rollpin fasteners are currently available in most of the larger pitches of both standard and heavy-series Morse Roller Chains. Standard cotter-pin chains are available and will be furnished unless otherwise specified.

M=PT

Morse *means* Power Transmission

MORSE

MECHANICAL *POWER TRANSMISSION* PRODUCTS

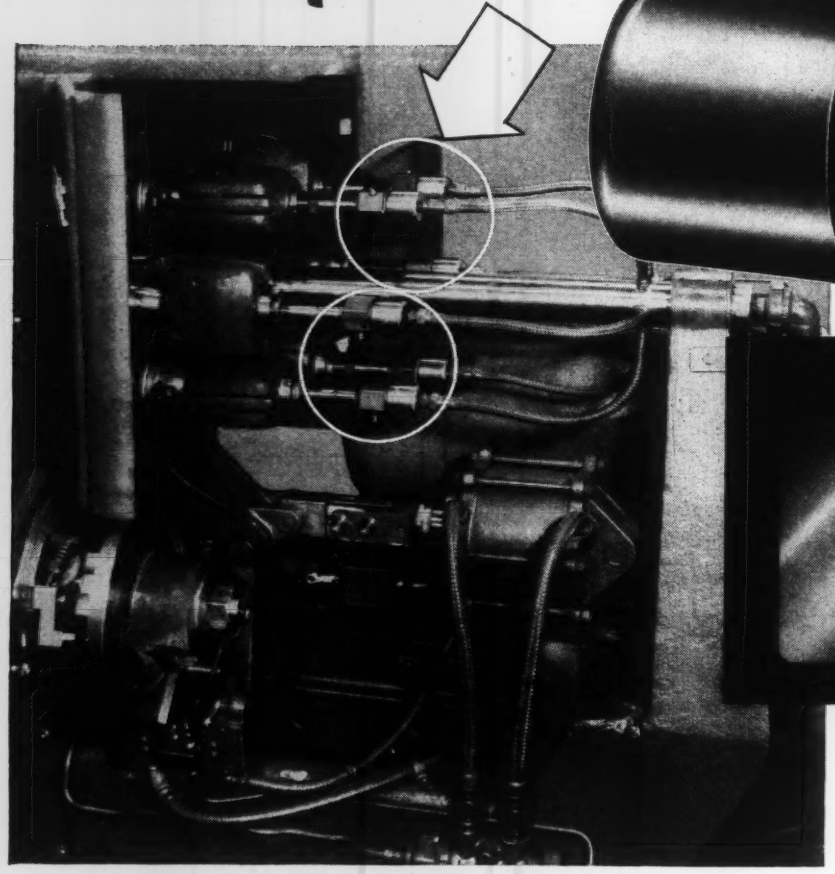
PRODUCTS OF B-W BORG-WARNER

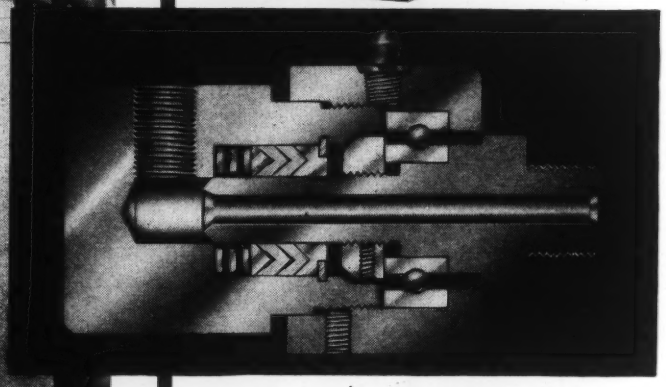
MORSE CHAIN COMPANY

Dept. 330 • 7601 Central Ave. • Detroit 10, Mich.

Low Torque! Leakproof!

BARCO





TYPE V REVOLVING JOINTS

- **LIGHT RUNNING!** Ball bearing design handles both radial and light end thrust with low torque and minimum wear.
- **LEAKPROOF!** Thanks to Barco's exclusive "CTR" V-ring type seal.
- **PRECISION-BUILT!** All parts machined to close tolerences. Parts interchangeable and renewable.
- **COMPACT, DURABLE!** Easy to install where space is limited. Withstands rugged service.
- **WIDE SPEED RANGE!** Up to 2500 RPM on light pressure applications. Lower speeds for high temperatures and pressures.

For High Speed Rotating Connections to

SPINDLES • CHUCKS • CLUTCHES

When you need *high speed, low torque, leakproof* rotary connections for fluid lines on MACHINE TOOLS, use Barco TYPE V Revolving Joints! The above photograph shows a typical installation on a new 6-spindle "Automatic" produced by Greenlee Bros. & Co., Rockford, Ill. This is but one of the many applications in the machine tool industry for TYPE V joints. Barco builds a complete line of standard and special revolving joints to meet virtually every need. *Barco Engineers are at your service; ask for recommendations.*

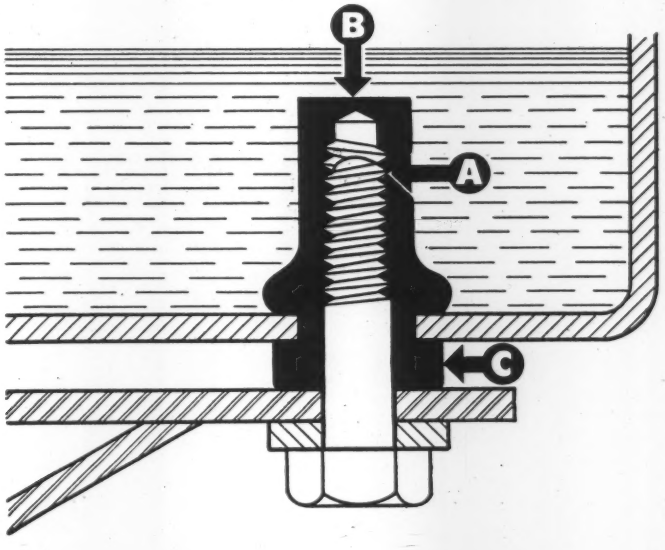
BARCO MANUFACTURING COMPANY

1806G Winnemac Avenue, Chicago 40, Illinois

***In Canada:* The Holden Co., Ltd.**

The Only Truly Complete Line of Flexible Ball, Swivel, Swing and Revolving Joints

RIVNUT replaces nut plate on oil tank . . . eliminates leaking, warping, thread cleaning



A MANUFACTURER of industrial oilers was brazing nut plates on his reservoir tanks for bolting to brackets. This sometimes caused leaks and warping. Since painting had to follow brazing, the threads had to be retapped.

By switching to Rivnuts, brazing was eliminated. Installed from one side, after painting, in one-tenth the time required for brazing, Rivnuts provide at least six clean threads (A) to take the attachment bolt. Rivnut forms oil-tight seal, has closed end (B). Special spacer head (C) of Rivnut forms uniform height feet.

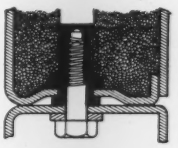
Closed-end Rivnut with spacer head is one of many types of Rivnuts. If you have a fastening problem, consult a Rivnut engineer. Write to The B. F. Goodrich Company, Dept. MD-62, Akron, Ohio.

What's your toughest fastening problem?

TORQUE?

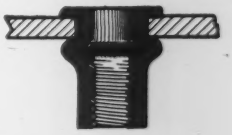
Special Rivnuts with splined shafts or key (above) supply needed torque resistance.

SEAL?



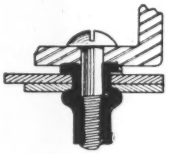
Firm grip of upset Rivnut on material, plus special closed end, gives tight seal.

MATERIAL?



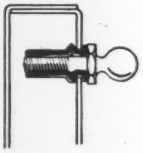
Even in thin materials, Rivnuts provide at least 6 threads for attachment.

ATTACHMENT?



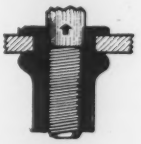
Fasten *with* Rivnuts—fasten *to* Rivnuts. Makes possible multiple fastening.

FINISH?



Rivnuts can be installed after finish, such as paint or porcelain, is applied.

LOAD?



Typical Rivnut thread strength: 6-32—964 lbs.; 8-32—1096 lbs.; 10-32—1326 lbs.*

RIVNUTS *lick them all!*

Figures given for aluminum. Loads for brass and steel Rivnuts about double.

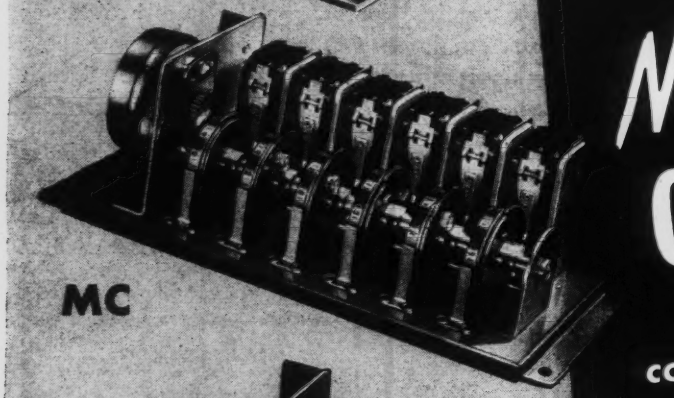
B.F.Goodrich RIVNUTS

The only one-piece blind rivet with threads

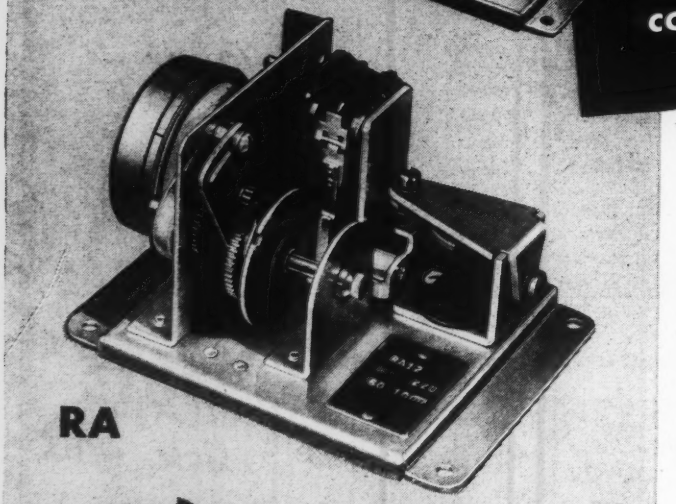
SEND NOW FOR FREE RIVNUT DEMONSTRATOR

Demonstrates with motion how you can use Rivnuts to fasten TO *and* fasten WITH. Explains construction, gives proved applications . . . Write for your free copy today to The B. F. Goodrich Company, Department MD-62. Akron, Ohio.

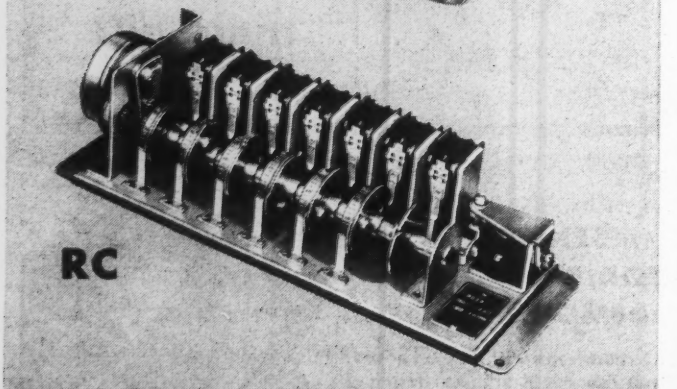
CM



MC



RA



RC

These Industrial Timer Corporation timers provide accurate and highly dependable instruments for control of a single operation or multiple operations (simultaneously or in sequence).

OUTSTANDING FEATURES ARE:

(1) the wide range of over-all time cycles obtainable from any one model;

(2) the ease with which over-all time cycles can be changed;

(3) the simplicity with which individual cams can be adjusted for ON and OFF periods, and positioned in specific timing sequence.

New! Synchronous Motor Driven CAM TIMERS

for single cycle and continuous recycling applications

Series CM CAM RECYCLING TIMERS

The Series CM Cam Recycling Timer repeats a definite electrical ON and OFF time cycle continuously. The cam is coupled to the motor by means of a simple gear and rack assembly—and the over-all time cycle can be easily changed by substituting gear racks. (Bulletin 33)

Series MC MULTI-CAM TIMERS

The Series MC Timer is identical to the CM Timer, but operates 2 to 6 circuits. All cams are mounted on a single shaft, which assures a common time cycle for all circuits. Each cam, however, is independently adjustable for a specific timing sequence. (Bulletin 34)

Series RA SINGLE CYCLE CAM TIMERS

The Series RA Timer provides a single time cycle upon being actuated electrically from remote control. A pawl on the cam eliminates necessity for prolonged closing of relay switch when starting. (Bulletin 35)

Series RC SINGLE CYCLE MULTI-CAM TIMERS

The RC is identical to the RA, but operates from 1 to 6 additional circuits. Thus it provides all the features of the Series MC Timer, plus the single cycle control afforded by the RA. (Bulletin 35)

Send us specifications, and we shall make recommendations based on your particular needs. Bulletins sent free on request.

MANUFACTURERS OF THESE AND OTHER TIMERS AND CONTROLS FOR INDUSTRY— Time Delay Timers • Manual Set Timers • Tandem Automatic Recycling Timers • Running Time Meters • Instantaneous Reset Timers

Timers that Control the Pulse Beat of Industry

INDUSTRIAL TIMER CORPORATION

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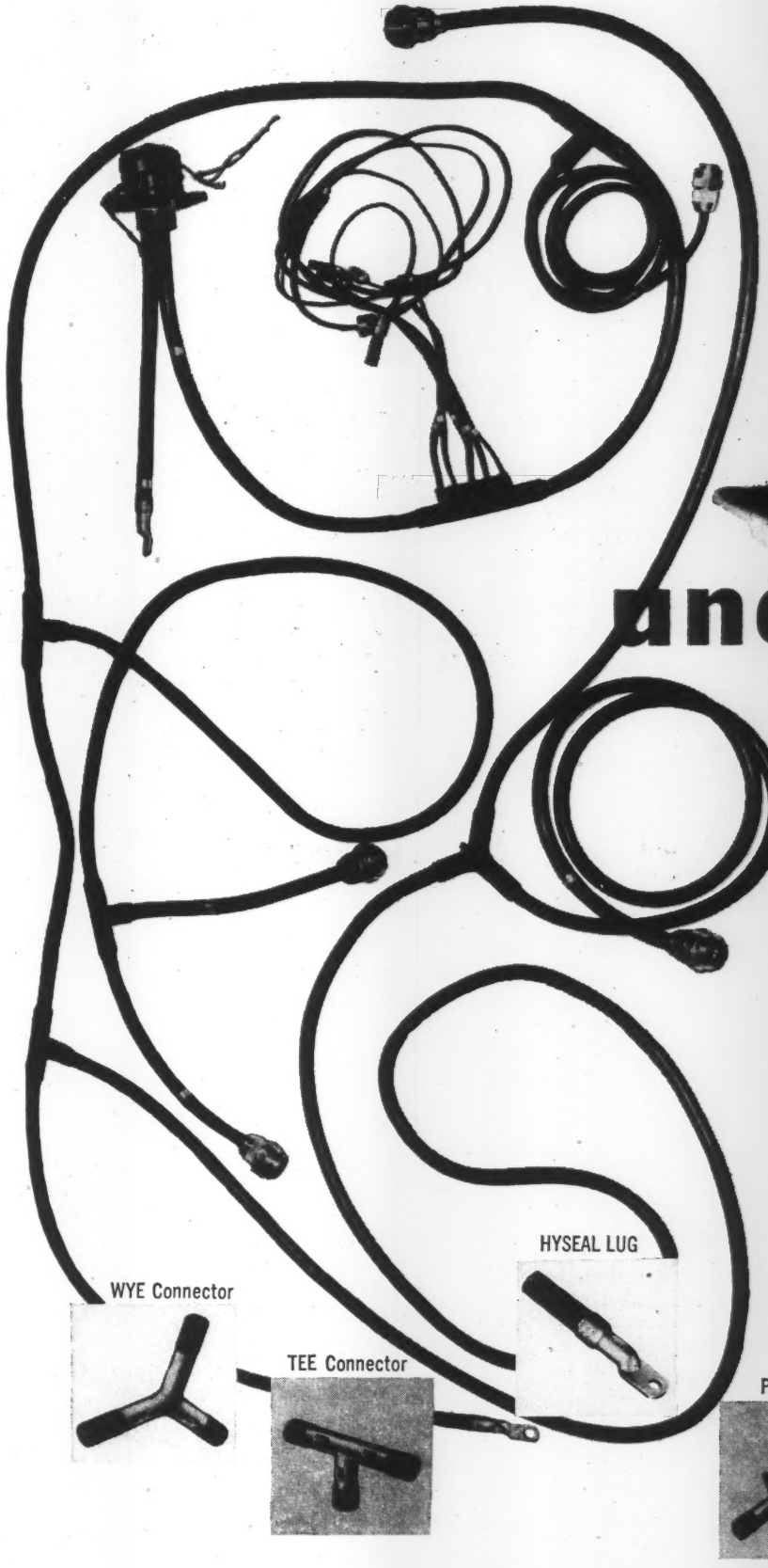


HOW THE ARMY HARNESSES A TANK FOR UNDERWATER PERFORMANCE

underwater

Watertight junctions, terminals, and multiple taps must protect automotive ordnance against mechanical or electrical failure under any conditions. Here's how Burndy engineers and harness manufacturers licked the water hazard.

Burndy Hyseal connectors—with extended shroud fitting over cable insulation—compressed to form a watertight union; plus—

Burndy high conductivity TEE tap connectors—modified to required small dimensions—with waterproof insulating compounds molded over entire assembly; plus—

Burndy automatic installation tools—which achieve tremendous savings in tooling, production, and inspection costs for prime as well as sub-assemblers.

For maximum connector efficiency with minimum size and weight—for mass production economy—call Burndy and have our field engineers study your connector problem.

BURNDY

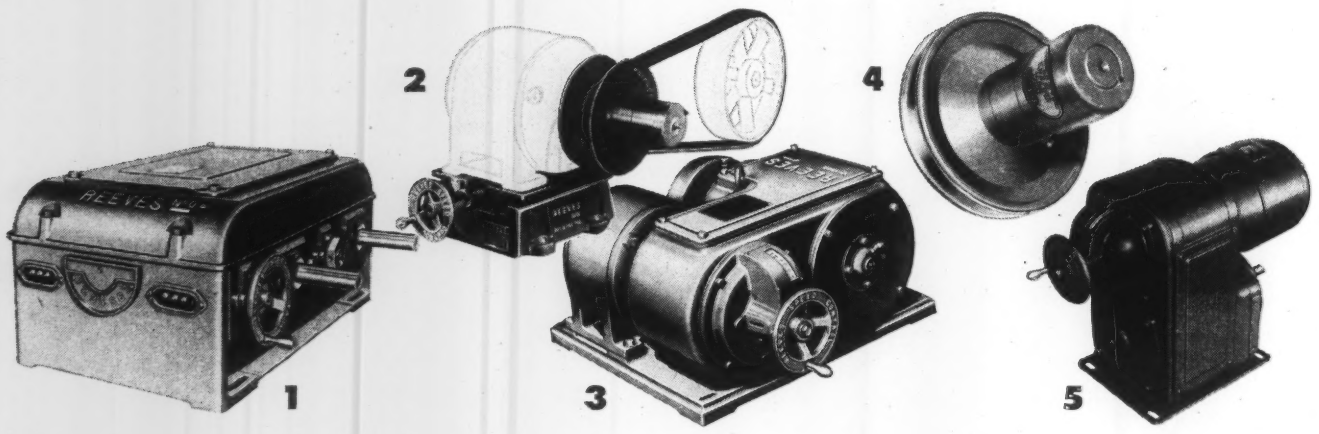
52-17 **BURNDY ENGINEERING COMPANY • NORWALK, CONNECT.** BURNDY CANADA, LTD., TORONTO 8, ONT.

To maintain uniform peripheral speed on increasing or decreasing diameters...

...equip the machines you build with

REEVES Speed Control

REEVES Variable Speed Drives are available in a *complete* range of designs, sizes, capacities and speed ratios



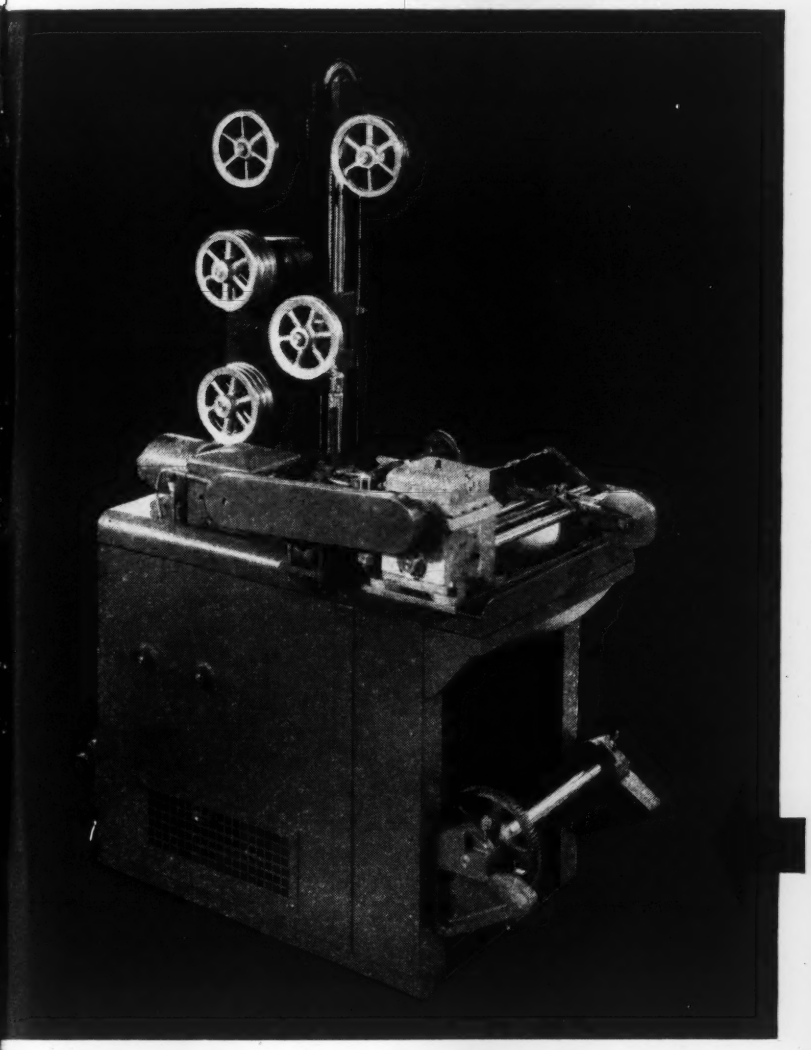
1. Variable Speed Transmission for providing infinite, accurate speed flexibility over a wide range —2:1 to 16:1. Sizes—fractional to 87 hp.

2. Vari-Speed Motor Pulley provides an instantly variable speed drive within 4:1 ratio for any constant speed motor. Available in sizes to 10 hp.

3. Motodrive combines motor, speed varying mechanism and reduction gears in a single unit. Speed variations 2:1 to 6:1 inclusive. Sizes to 25 hp.

4. Vari-Speed Jr., a compact, low-cost unit for light machinery. Takes any standard V-belt. Ratios, 1¾:1 to 2¾:1. Sizes—⅛ through 1½ hp.

5. Fractional HP Motodrive provides wider work range; takes less space! As small as 9⅜" high—in ¼, ⅓, ½ and ¾ hp sizes. Ratios up to 10:1.



REEVES Speed Control is infinitely variable, accurate, positive!

You can *be sure* of infinitely variable, accurate and positive speed control for the machines you build when you specify REEVES!

The REEVES line—tested and proved in almost every conceivable application and industry—is the most complete on the market. Built around the basic units shown at lower left, the REEVES line includes a wide range of designs, sizes, capacities and speed ratios, with manual, push-button or completely automatic controls; also REEVES "Internal Operating Parts" for incorporation within the machine framework.

Make *sure* that your machines provide the right speed for every operation and every operator under every changing condition. Standardize on REEVES!

EXAMPLE: A REEVES Vari-Speed Motor Pulley, a REEVES Variable Speed Transmission and a REEVES Vari-Speed Motodrive are used as standard equipment on this Wind-Up Machine, manufactured by Industrial Ovens, Incorporated, for the lacquering of wire cable. Motodrive is used as the main drive of the wind-up processing machine. It drives the pull roll capstan, establishing the line speed at from 200 to 1,000 feet per minute; and also drives the Hydraulically Controlled Transmission, which automatically maintains constant tension and velocity. Tension from a few ounces to hundreds of pounds can be attained and held during the entire operation. Motor Pulley, driven by the Transmission, provides rate of traverse of wire on cable reel.

If the control of peripheral speed (or tension) on increasing and decreasing diameters is essential in the machines you design or build . . . then REEVES Speed Control is an essential item of standard equipment.

Many of the 2,100 different makes of machines now incorporating REEVES Speed Control as original equipment do so for this very reason . . . as on textile, paper or printing machines, wire and cable reeling equipment and many other types of machinery where variations in speed or tension would result in breakage, excess stretch, etc., thus resulting in interrupted production and defective products.

Here, again, is but one of eight basic functions (listed at right) which REEVES Speed Control is profitably performing on more than 265,000 production machines. Look at all eight and see which one applies to your speed control problem. Then talk it over with the REEVES field engineer in your area. Write for his name and for *free* catalog described below. No obligation, of course.

REEVES PULLEY COMPANY · COLUMBUS, INDIANA

Recognized leader in the specialized field of speed control engineering

REEVES performs these eight basic functions

1. Handles more sizes, shapes and materials.
2. Matches variances in number or skill of operators.
3. Compensates for changes in consistency, density or viscosity of materials in process.
4. Accurately controls heating, baking, drying, cooking, cooling or chilling time.
5. Maintains uniform peripheral speed (or tension) on decreasing or increasing diameters.
6. Maintains uniform pressure, weight, liquid level, temperature and other variable elements.
7. Regulates conveyor speeds—even to fractions of an inch per minute.
8. Synchronizes all working parts—of one machine or machines operating in series.

accurate · variable

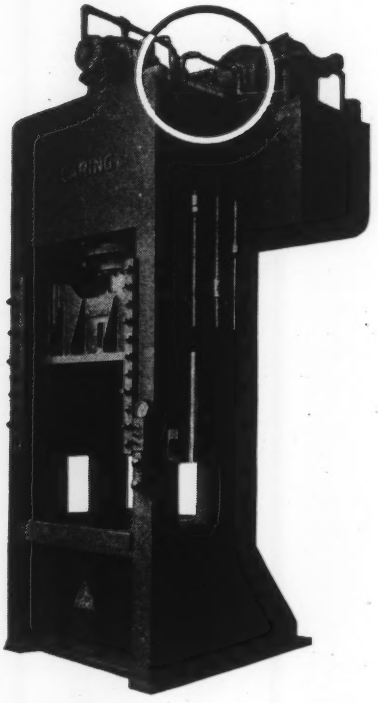
REEVES *Speed Control*

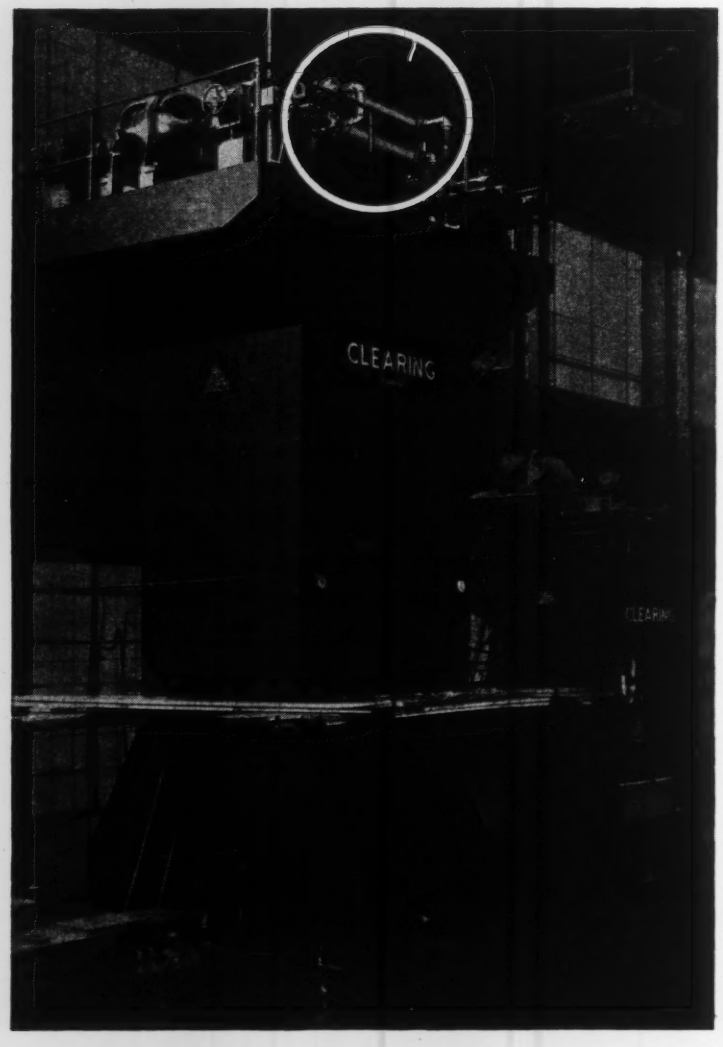
FREE!

132 pages—most comprehensive book on speed control ever published. Write today for REEVES Catalog H48a-3N.

compactness

...a big factor in Clearing's selection of Ross Exchangers





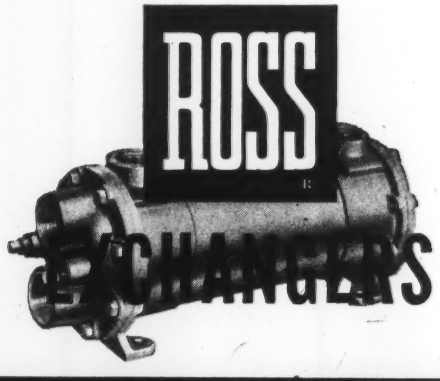
Compactness that lends itself to a neat installation with the hydraulic unit . . . that's a big factor in the selection of Ross Type BCF Exchangers for Clearing Hydraulic Presses.

Whether it's a 150-ton or a 2200-ton press (like those illustrated), the Clearing Machine Corporation can thus furnish *dependable protection* of the hydraulic oil temperature with a minimum of installation time and within a minimum space.

Today, manufacturers of *all* types of hydraulic machines and equipment are profiting from the singular advantages of Ross Type BCF Exchangers. Performance proved, built from durable copper and copper alloy materials throughout, they can be depended upon for long, hard service. Pre-engineered and completely standardized, they are available from stock.

For details, request Bulletin 1.1K5.

ROSS HEATER & MFG. CO., INC., Division of American Radiator & Standard Sanitary Corp., 1429 West Avenue, Buffalo 13, N. Y. In Canada, Horton Steel Works, Limited, Fort Erie, Ont.



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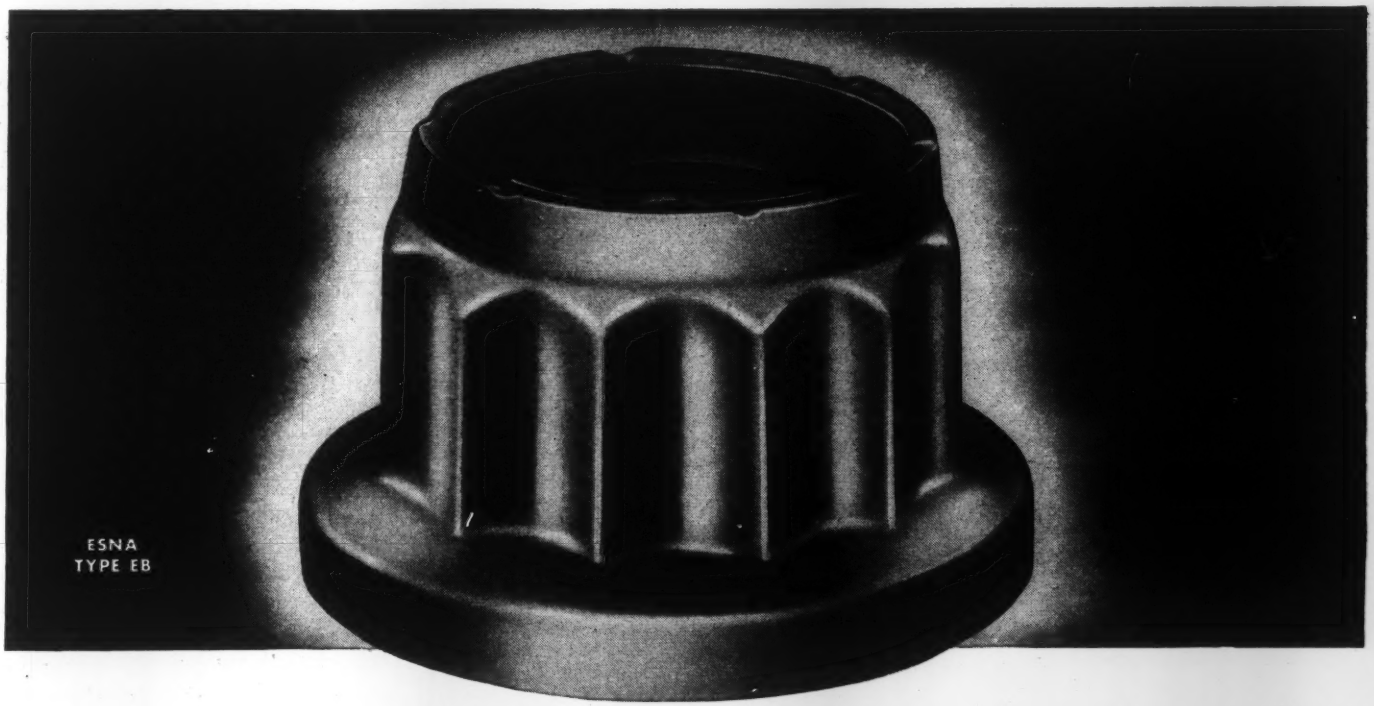
High Strength DOUBLE HEX NUT

CUTS SIZE...WEIGHT OF AIRFRAME COMPONENTS



—the famous Self-Locking Red Elastic Collar

***protects permanently against* IMPACT! VIBRATION!**

The NEW ESNA HIGH Strength-Double Hex Nuts have been scientifically engineered to accomplish distribution of thread load with minimum weight and wrench diameter. They develop 185,000 psi. min. in NAS high strength aircraft bolts, and are completely interchangeable with existing internal wrenching nuts; yet this unique double hex design saves 66% in weight and 50% in height, compared to the old internal wrenching types. These savings in weight and clearance gain greater importance when multiplied by the additional savings in the size and weight of component parts or fittings which the new design makes possible to employ.

Because of their light weight . . . extra safety . . . easy field identification . . . and reduced wrenching area, ESNA Type EB Nuts are accepted as standard for all high tensile applications by airframe manufacturers. Also, of great importance maintenance-wise is the fact that no special wrenches are required—any socket wrench will do.

Further—like all Elastic Stop Nuts—the NEW High Strength Nut remains self-locking in both fully seated and positioned settings.

HERE'S A CHALLENGE: Send us complete details of your toughest bolted trouble spot. We'll supply test nuts—FREE, in experimental quantities. Or, if you want further information, write for literature. Elastic Stop Nut Corporation of America, Dept. N4-64, Union, New Jersey. Representatives and Agents are located in many principal cities.

ESNA TRADE MARK

ELASTIC STOP NUTS

HIGH TENSILE

ANCHOR

HIGH TEMPERATURE

SPLINE

CLINCH

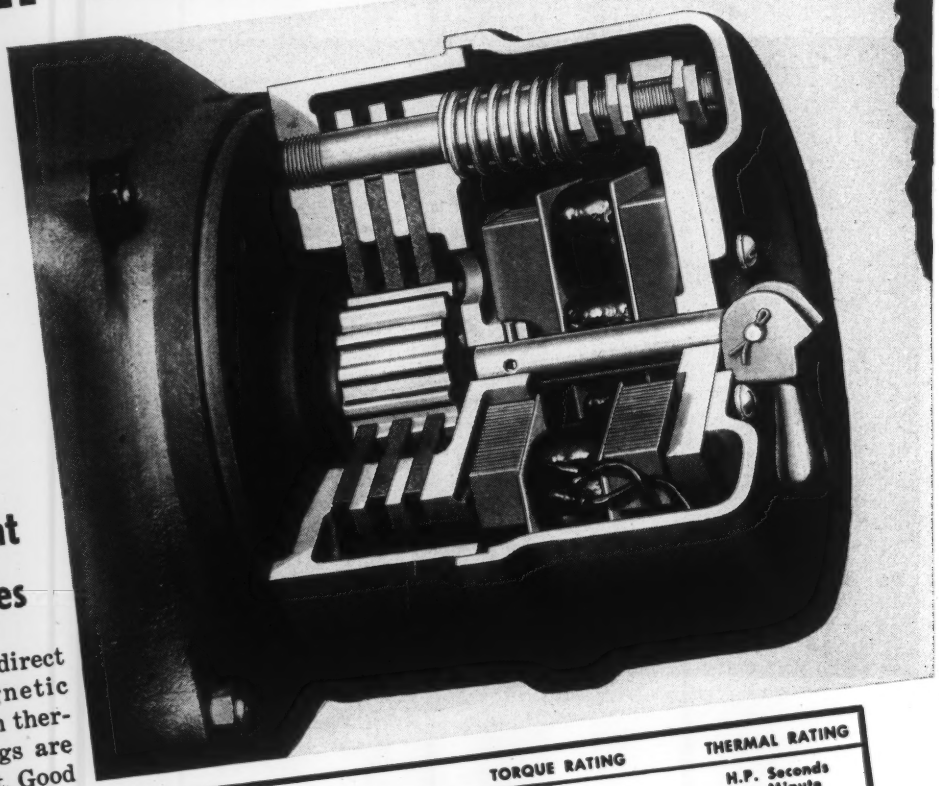
GANG CHANNEL

NYLON CAP

NYLON AND FIBER INSERT TYPES ARE QUALIFIED TO SPEC. AN-N-5

NEW DINGS MAGNETIC BRAKES HAVE HIGH THERMAL RATINGS

DIRECT-ACTING FOR AC OR DC MOTORS



Designed to Mount on Nema C Flanges

The new line of Dings direct acting, disc type magnetic brakes offers new highs in thermal ratings. These ratings are listed in the table at right. Good heat dissipation characteristics contribute greatly to the ability of the magnet coils to operate on a 24 hour per day basis without overheating. The combination of high thermal ratings and cool magnet operation increases the trouble-free life expectancy of Dings brakes.

There is no solenoid nor mechanical linkage between the magnet and the pressure plate. Spring tension engages the brake. Direct magnetic pull on the armature releases it. The brake is ruggedly constructed, compact, easily accessible for maintenance and is designed to mount easily on Nema Type C motor flanges. In adjusting, it is impossible for the operator to increase the torque beyond the ability of the magnet to release. An external manual release lever is incorporated. This mechanism automatically resets itself. For complete details, send for the new Brake Bulletin.

For NEMA Motor Frame	TORQUE RATING Lbs., Ft.	Duty	THERMAL RATING H.P. Seconds per Minute Cont. or Inter.	60 Minutes
203C-254C	10	Cont.	10	....
203C-254C	15	Inter.	10	15
203C-254C	25	Cont.	12	....
284C-326C	25	Cont.	14	....
284C-326C	35	Inter.	14	21
284C-326C	50	Cont.	16	....
284C-326C	75	Inter.	16	24
284C-326C	75	Cont.	18	....
284C-326C	90	Inter.	18	27

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All About Dings Brakes
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Write today

DINGS BRAKES, INC.

Reprints from this or other Logbook pages are available for your files. Request them from our Redwood City, California office

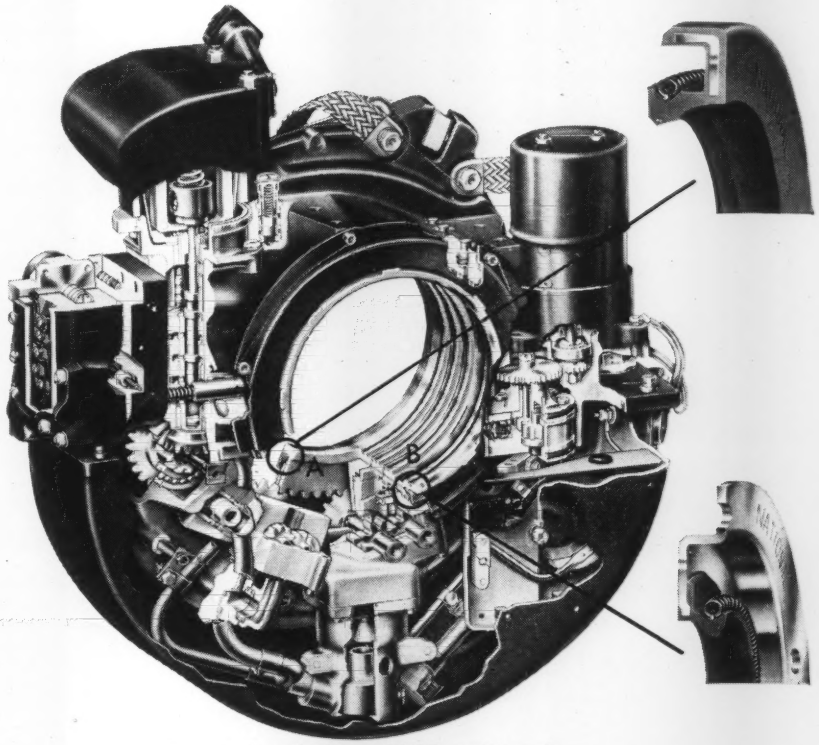


Figure 1. Propeller Integral Oil Control Assemby

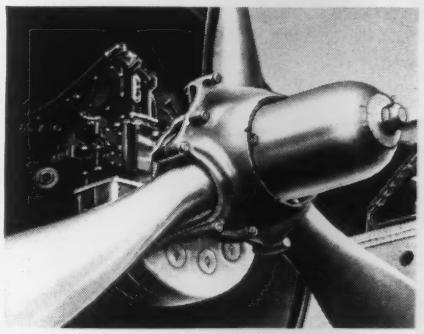
"No-leakage" sealing at high surface speeds throughout a broad range of temperatures

In the design of aircraft assemblies, engineers are often faced with a combination of problems not encountered in surface equipment. Important among these from an oil-sealing standpoint are temperature extremes, high surface speeds and the necessity of preventing any oil or fluid loss.

Each of these phenomena is an important factor in sealing the Integral Oil Control Assembly of Hamilton Standard propellers for large aircraft. In this assembly, the specific requirement is to provide a positive seal at front and rear transfer bearing positions throughout a wide range of operating conditions. Sealing is on a 6.5" diameter and speeds reach 3,250 f.p.m. Temperatures vary from external conditions of −65°F to operating conditions of 220°F. No leakage is permissible because of the limited oil supply in the system and the dangers implied by oil leaks on an aircraft engine. The seals must be extremely compact due to critical space and installation limitations. And, sealing members must be suitable for use with AN-0-8, Grade 1100 and AN-0-9, Grade 1010 fluids, and MIL-0-5606 oil.

National Oil Seal engineers, working with Hamilton Standard, provided seals that answered the problems posed by the assembly. At the rear bearings (Fig. 1, "A"), a modified National 350,000 Syntech* (synthetic rubber) seal was used. Modification included extending the sealing lip to increase flex action. The seal press-fits into a 7.432" bore, yet it is only 0.406" wide and less than 0.6" deep at cross-section. At the front bearing ("B") a similar seal with a specially formed case is used.

Both seals in this assembly are National Syntech units with accurately spring-tensioned, precision-molded and precision-trimmed synthetic rubber sealing members. Syntech seals are ideal for many such applications because they operate efficiently at high



speeds and temperatures, and are unaffected by most industrial oils or fluids.

The seals used in the application are of special design to meet special sealing requirements. Many sealing problems, however, can be solved by utilizing standard designs—often at an appreciable saving in time and tooling costs. In either case, National Oil Seal Engineers are at your service to apply almost 30 years of practical sealing experience toward solution of your problem. Write today for information.

Trade Mark Registered

"Let Your Decision be Based on Precision"

NATIONAL OIL AND FLUID SEALS

NATIONAL MOTOR BEARING CO., INC.

General Offices: Redwood City, California
Plants: Redwood City, Calif.; Downey (Los Angeles County), Calif.; Van Wert, Ohio

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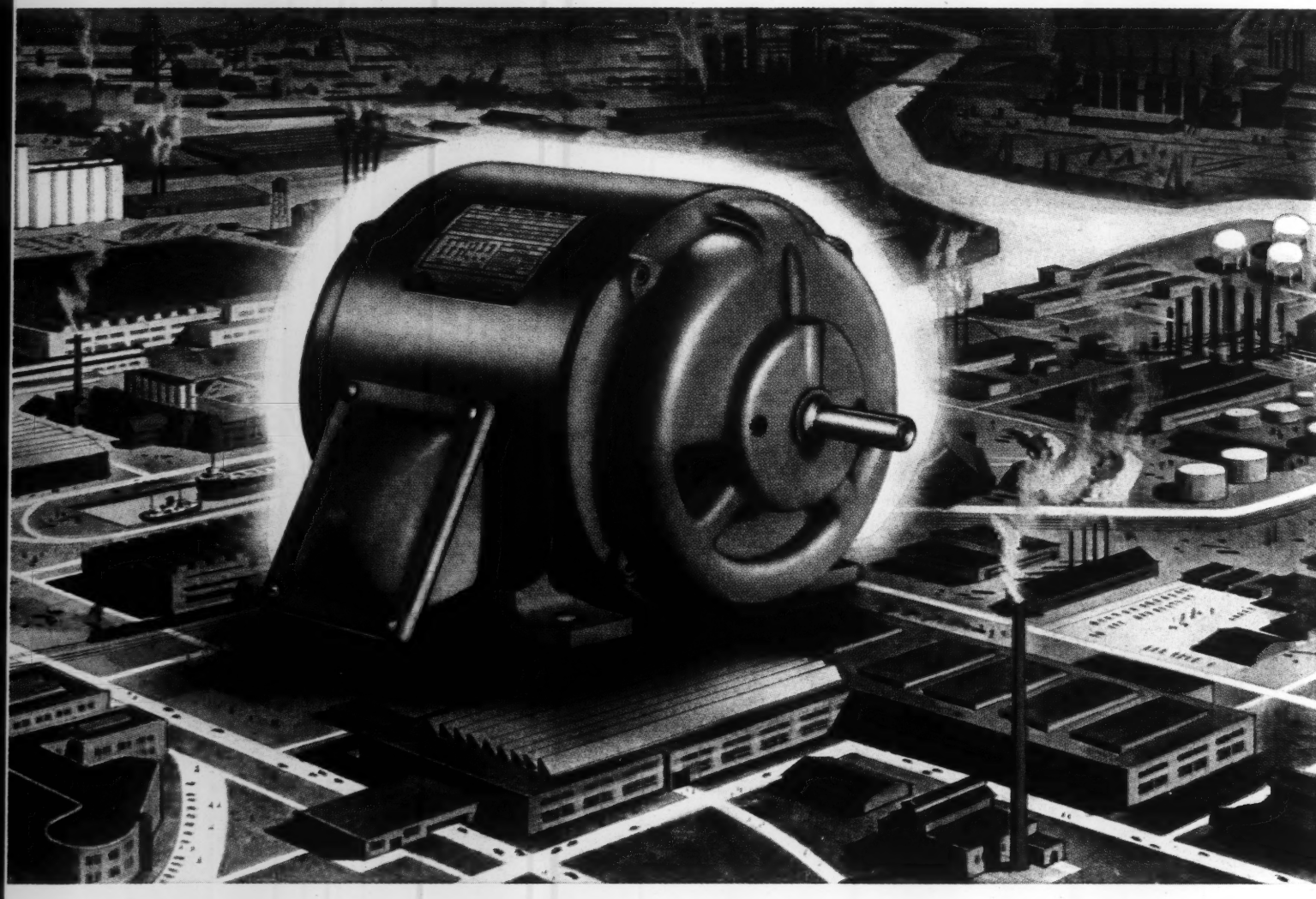


Everywhere in Every Industry, this Fact is Being Proved...

"All Motors are not alike"

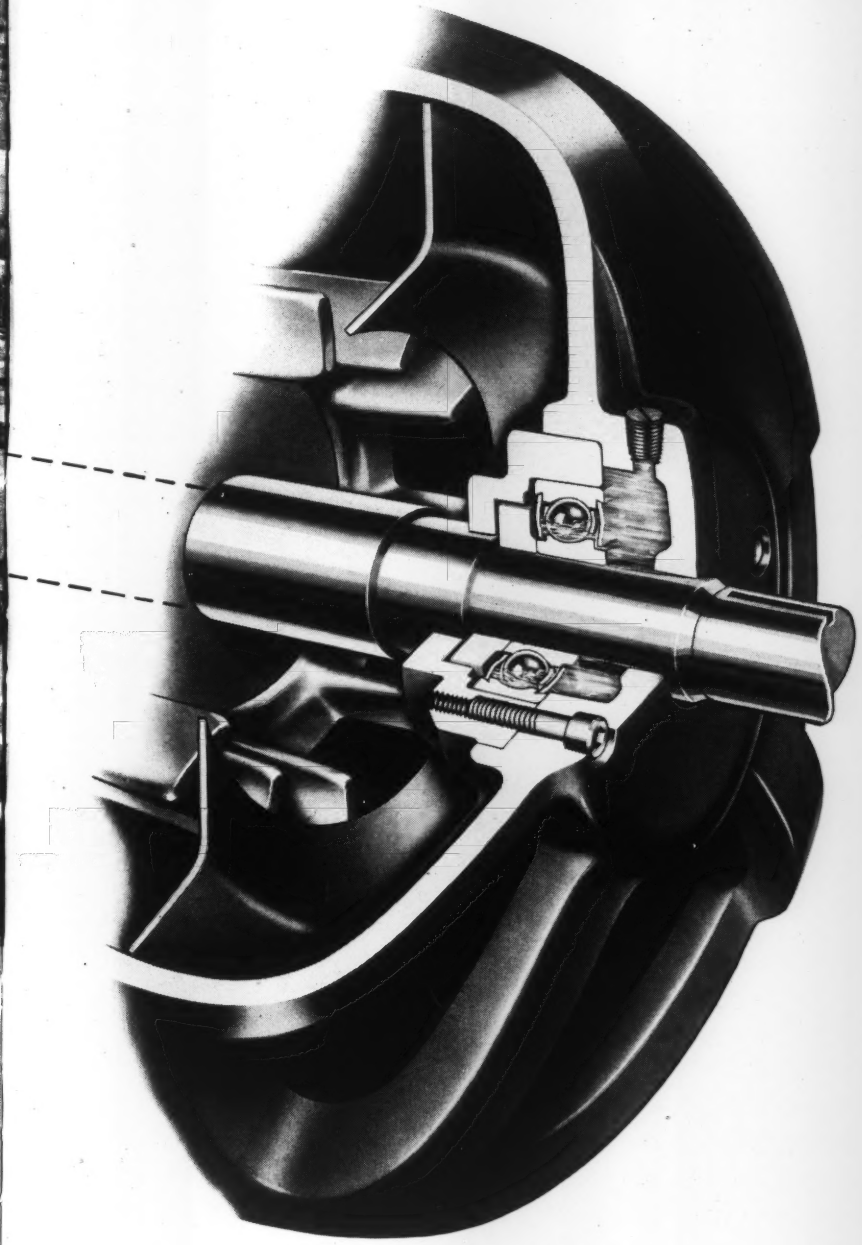
By their superior performance—frequently in rugged 24-hour-a-day service—Reliance Precision-Built A-c. Motors are proving in every industry that *"All Motors are not alike"*. Here are motors which are made differently and made better—to deliver dependable power longer. Their original factory bearing lubrication, for example, provides more operating hours before re-lubrication is necessary than that of any other pre-lubricated bearing. And on the next page you will find a check list of features which combine to make the Reliance design the best pre-lubricated bearing design you can obtain in any motor made today!

Precision-Built

15 REASONS WHY . . .

the RELIANCE Pre-Lubricated Bearing Design

is the BEST in Electric Motors



- Bearing sealed from dirt and other foreign material.
- Enclosed bearing housing.
- Bearing can be re-lubricated without being disassembled.
- Motor can be re-greased without removing drain plug.
- Automatic grease relief to suit any lubrication system.
- Protection against grease entering windings.
- Balls free of direct pressure during lubrication.
- Bearing can be removed without danger of distortion.
- Reservoir to protect against under-greasing.
- Standard commercial ball bearings.
- Larger grease reserve than provided with any standard bearing.
- Grease supply free of churning action.
- Measuring unnecessary to prevent over-greasing.
- Unnecessary to grease equally at each side of ball race.
- Lubricant is retained in ball race.

Write for Bulletin detailing all of the advantages you get with the RELIANCE Pre-Lubricated Bearing Design

Cutaway views, comparison chart and statements by bearing manufacturers offer more complete evidence of the superiority of the Reliance Pre-Lubricated Bearing Design. Specify Bulletin B-2201.

Reliance PRECISION-BUILT A-c. Induction Motors available from 3/4 to 300 horsepower

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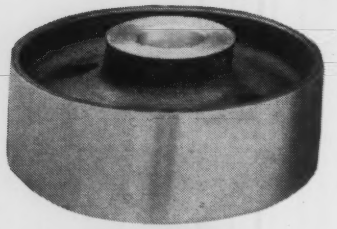
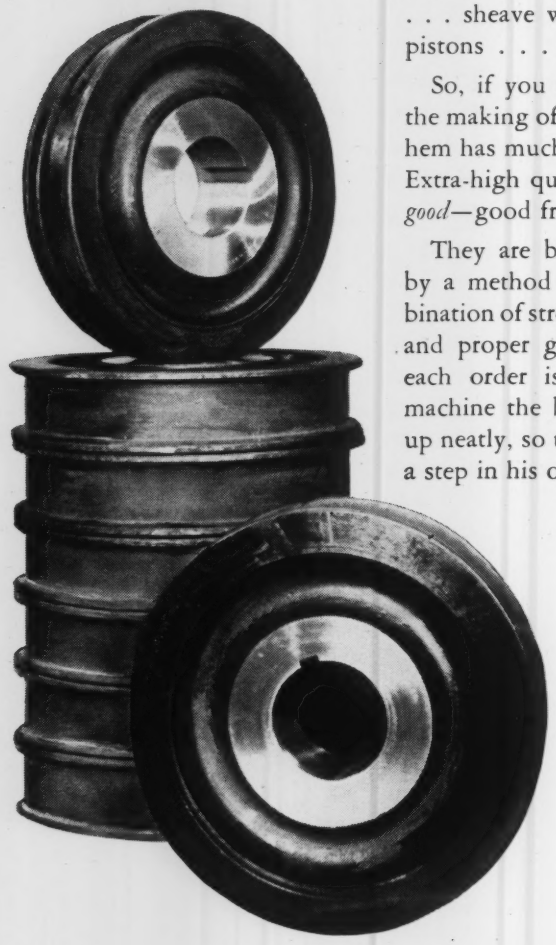
RELIANCE ELECTRIC AND ENGINEERING CO.

1079 IVANHOE ROAD, CLEVELAND 10, OHIO • CANADIAN DIVISION: Welland, Ontario

The steel blanks with an almost endless *VARIETY of USES*



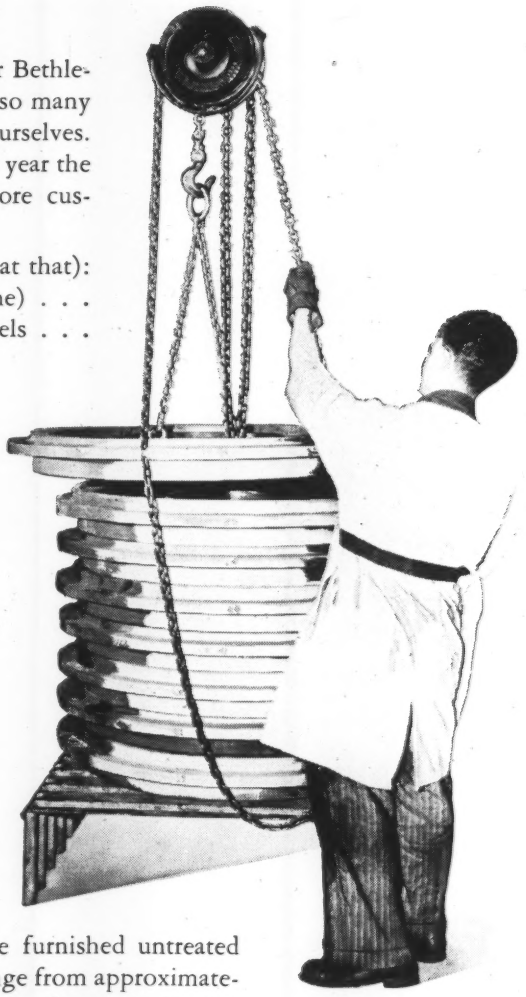


There are so *many* uses for Bethlehem circular steel blanks—so many we may not know them all ourselves. But we do know that every year the number grows larger, as more and more customers find new applications.

Here's a partial list (and very partial, at that): Gears (spur, bevel, miter, herringbone) . . . crane-track wheels . . . industrial wheels . . . turbine rotors . . . flywheels . . . motor brake wheels . . . clutch drums . . . sheave wheels . . . locomotive pistons . . . tire molds and rings.

So, if you require steel blanks in the making of your products, Bethlehem has much to offer. Nice variety. Extra-high quality. These blanks are *good*—good from rim to rim.

They are both forged and rolled by a method that produces a combination of strength, uniform density, and proper grain flow. And before each order is shipped, we rough-machine the blanks and clean them up neatly, so that the customer saves a step in his own plant.

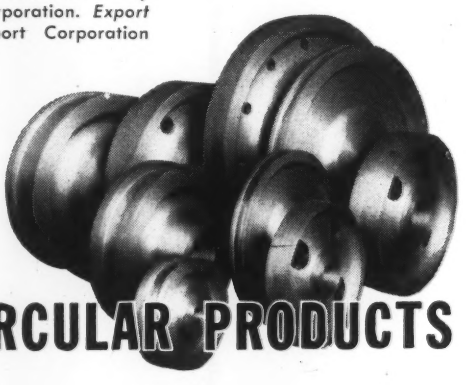


Bethlehem blanks are furnished untreated or heat-treated; sizes range from approximately 10 to 42 in. OD. Care for more details? We'll gladly supply them at your convenience.

BETHLEHEM STEEL COMPANY
BETHLEHEM, PA.

On the Pacific Coast Bethlehem products are sold by Bethlehem Pacific Coast Steel Corporation. *Export Distributor:* Bethlehem Steel Export Corporation

BETHLEHEM STEEL



BETHLEHEM ROLLED-AND-FORGED CIRCULAR PRODUCTS

Check These 2 Ways to Cut Drive Costs

TEXROPE V-Belt Drives with low cost 1800 rpm motors will often do work of expensive motors and control.

For example you can:

1. Provide slow speed (such as 450 rpm) at the driven shaft using a standard 1800 rpm motor. A standard 4 to 1 *Texrope* drive will do it. And the savings over a 450 rpm cage motor, direct connected are:
   - 600 pounds weight (in 15 hp size).
   - About $200 in cost.
   - About 8% increase in efficiency.
2. Use *Vari-Pitch* sheaves on a *Texrope* drive and provide smooth, stepless speed adjustment. There's no need for a high cost special motor or electric control to provide up to 2 to 1 speed range.

For help on your drive problem, whatever it may be, call your nearby Allis-Chalmers distributor or district office, or write Allis-Chalmers, Milwaukee 1, Wis.

A-3734

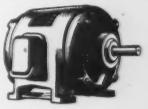
Texrope and *Vari-Pitch* are Allis-Chalmers trademarks.

Sold . . .

Applied . . .

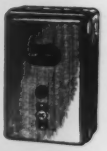
Serviced . . .

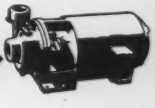
by Allis-Chalmers Authorized Distributors, Certified Service Shops and Sales Offices throughout the country.



MOTORS — ½ to 25,000 hp and up. All types

CONTROL — Manual, magnetic and combination starters; push button stations and components for complete control systems.





PUMPS — Integral motor and coupled types from ¾ in. to 72 in. discharge and up.

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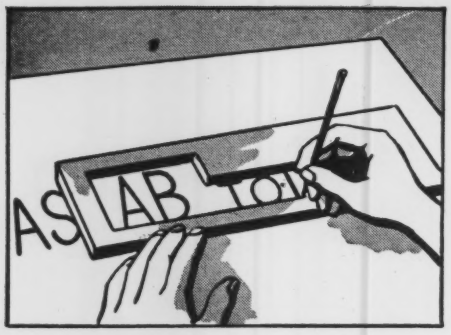
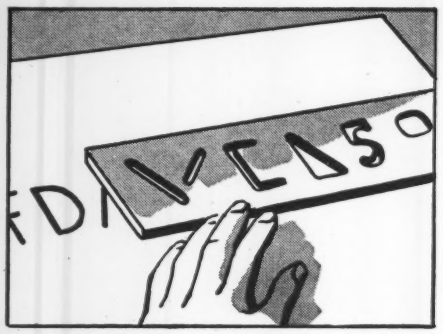
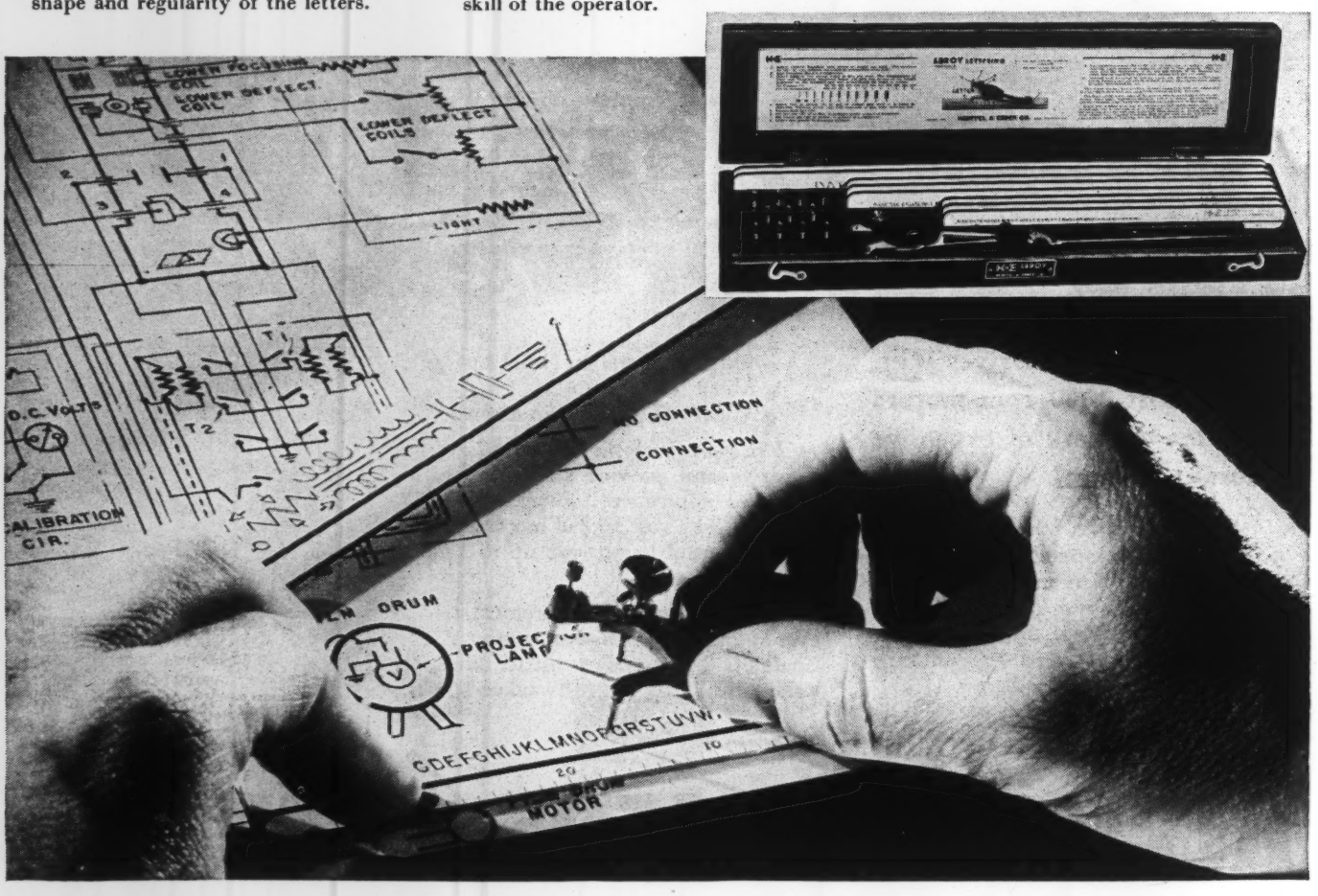




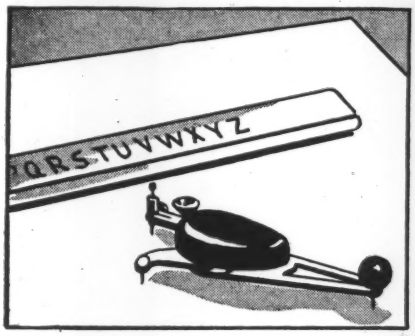
If the results of freehand lettering were always something to be proud of, there would be little or no need of special lettering aids. But as draftsmen know, freehand lettering is often irregular in appearance, and seldom can two men in a department letter exactly alike. Even as simple a device as a height guide helps considerably. Yet it fails in the important function of controlling the shape and regularity of the letters.

An obvious way of controlling shape as well as size is to use a stencil guide. To avoid the broken lines characteristic of stencils, guides were first devised consisting of cut-out portions of letters which could be combined to compose complete letters. However, they covered the work in progress, obscuring it from view, and the appearance of the finished lettering still depended largely on the skill of the operator.

To afford greater control, a stencil guide was developed on which all but a few letters were complete in outline. Shifting the guides with a shuttling motion permitted the breaks in the lines to be filled in. Like all stencils, these too covered up the lettering, and they also had to be supported slightly above the drawing surface so they could be shifted without smearing the work.



to LEROY® was bound to come!



Instead of stencils, the LEROY Lettering Set has templates with grooved characters which guide the pen virtually by "remote control". In place of a hand-held pen, there is a movable scriber. It combines a lettering pen, a pin that fits in and follows the grooved characters, and a sliding pivot, and it holds them in triangular relationship. Because a straight groove in the template restricts the motion of the pivot, the movement of the pen is governed entirely by the movement of the tracer pin.

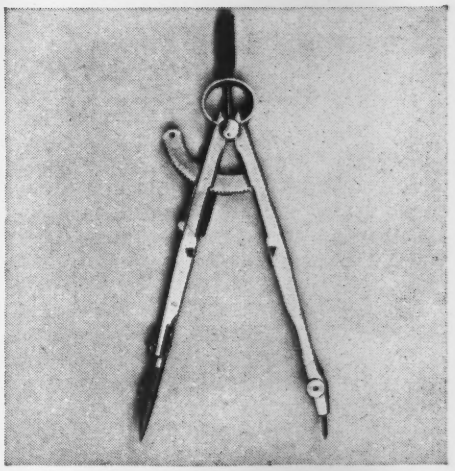
With the LEROY scriber, the lettering is done above the template where it is always visible and safe from smearing, instead of through a stencil. Each letter, numeral or symbol is formed completely with unbroken lines, without moving the template. Its size and shape are entirely controlled by the template grooves, so that rapid, uniform lettering is easy. By a simple adjustment of the scriber, either vertical or slant lettering is possible from the same template.

With a LEROY Lettering Set, you can draw capitals, lower case letters and numerals from a single template. You can form perfect letters on the first trial, and can develop speed with a few minutes' practice. No guide lines, no "roughing in", no erasing. You can be sure of uniformity throughout the drafting room, in pencil or ink.

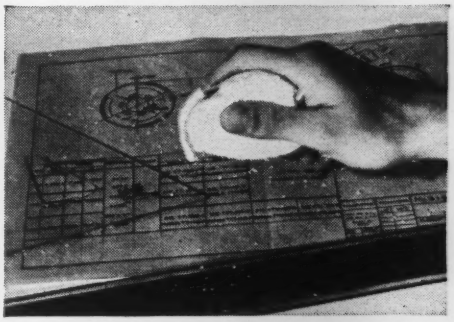
There are LEROY templates and pens for every size and thickness of lettering normally required, as well as templates with engineering and scientific symbols and with special alphabets. K&E can also produce special templates for phrases, symbols or trade marks of your own design.

Ask your K&E Distributor or Branch to tell you about other LEROY features, or write to us for complete booklet on LEROY.

The Right Angle



You will find "Quick Set" the handiest large bow combination you've ever used. It has a trigger-quick action for coarse settings plus micrometer adjustment for precise settings. Complete with interchangeable pen and pencil inserts for circles up to 12½" diameter in pencil and 12" diameter in ink.



Cut down on the clean-up with an ABC* Dry Clean Pad. Tiny gum eraser particles sift through the mesh of the pad. Sprinkle them in a light film over the drawing surface before starting work and you'll have no graphite smears. Use it the same way for final clean up. Contains no grit or abrasive.

*Trade Mark

K+E

KEUFFEL & ESSER CO.

Drafting, Reproduction, Surveying Equipment and Materials, Slide Rules, Measuring Tapes

NEW YORK • HOBOKEN, N. J.
CHICAGO • ST. LOUIS • DETROIT
SAN FRANCISCO • LOS ANGELES • MONTREAL

TEFLON is

a trademark of E. I. DuPont Co. for polytetrafluoroethylene. It is supplied by C-D-F in tapes and sheets, both plain and fibre glass cloth supported.

HEAT RESISTANT

Teflon may be used continuously at 200°C. (392°F.); or for short periods at 250°C. (482°F.). Meets A.I.E.E. Standards for Class H electrical insulation.

MOISTURE RESISTANT

Teflon products have practically zero water absorption and are unaffected by fungus, humidity and temperature changes. It remains pliable at —87.5°C. (—100°F.).

ARC RESISTANT

Teflon will not carbonize, but rather will vaporize. When the arc is extinguished, full insulation is restored.

CHEMICAL RESISTANT

Teflon is the most inert of all commercial thermoplastics and is not affected by any known solvent.

THAT'S WHY C-D-F TEFLON TAPES AND SHEETS CAN OFFER THESE BIG ADVANTAGES

FOR LINING SLOTS C-D-F sheets of fibre glass cloth supported Teflon can be cold-formed into easily loaded slot liners. Teflon is naturally slippery smooth, with plenty of "snap back." High in dielectric strength, liners are rated Class H insulation.

FOR WRAPPING CABLES C-D-F Teflon tapes are tough, strong, and stretchable. Teflon can be supplied unsupported, or combined with fibre glass fabrics in a variety of widths and thicknesses. It is suitable for winding around sharp bends or odd shapes.

FOR CHEMICAL AND MECHANICAL USES Remember, Teflon is non-adhesive and chemically inert. Bakers, food packagers, and pump manufacturers use it. For applications requiring extreme electrical insulation stability, high temperature or resistance to corrosion, C-D-F unsupported and fibre glass cloth supported products can do a job for you.

C-D-F's work with Teflon is really rolling! New applications are being developed daily in our laboratories by specialists who are devoting their entire time to improving and developing new Teflon products. Start talking Teflon with the man from C-D-F (sales offices in principal cities)—he's a good man to know!

CDF

Continental-Diamond Fibre Company

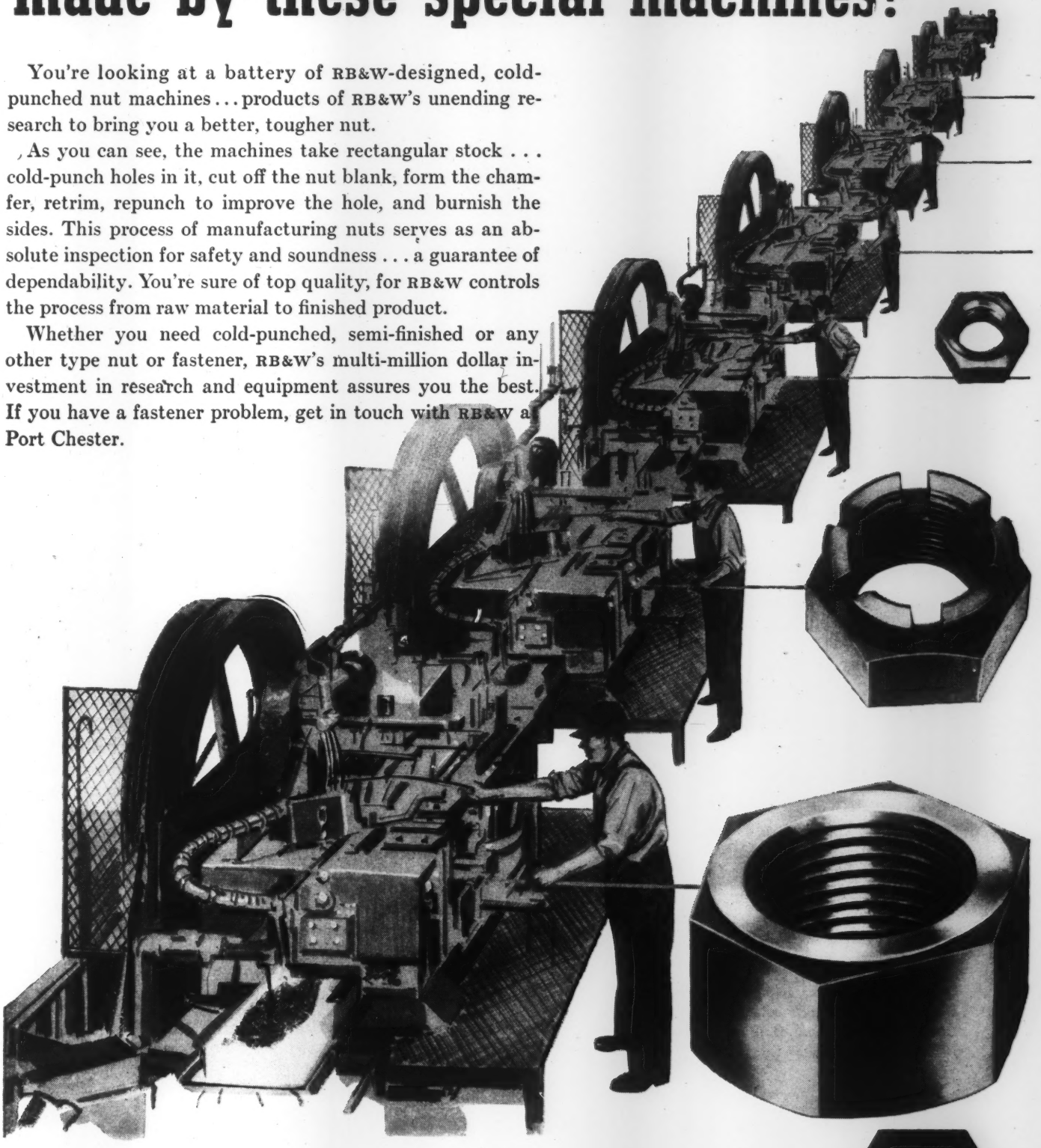
NEWARK 23, DELAWARE

Get safer, stronger assembly with nuts made by these special machines!

You're looking at a battery of RB&W-designed, cold-punched nut machines... products of RB&W's unending research to bring you a better, tougher nut.

As you can see, the machines take rectangular stock . . . cold-punch holes in it, cut off the nut blank, form the chamfer, retrim, repunch to improve the hole, and burnish the sides. This process of manufacturing nuts serves as an absolute inspection for safety and soundness . . . a guarantee of dependability. You're sure of top quality, for RB&W controls the process from raw material to finished product.

Whether you need cold-punched, semi-finished or any other type nut or fastener, RB&W's multi-million dollar investment in research and equipment assures you the best. If you have a fastener problem, get in touch with RB&W at Port Chester.



RUSSELL, BURDSALL & WARD BOLT AND NUT COMPANY

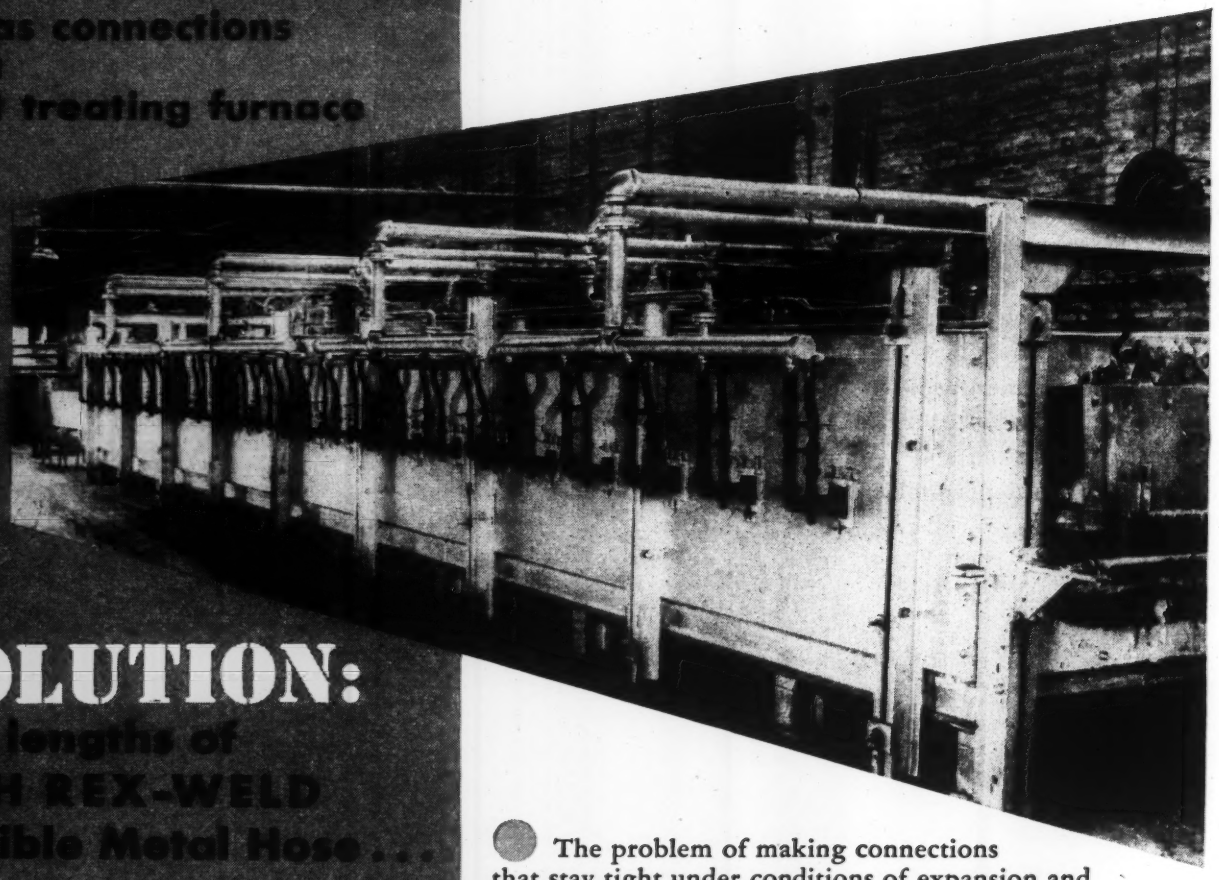
Plants at: Port Chester, N. Y., Coraopolis, Pa., Rock Falls, Ill., Los Angeles, Calif. Additional sales offices at: Philadelphia, Detroit, Chicago, Dallas, Oakland. Sales agents at: Portland, Seattle. Distributors from coast to coast.

RB&W
THE COMPLETE QUALITY LINE

107 YEARS MAKING STRONG THE THINGS THAT MAKE AMERICA STRONG

PROBLEM:

How to absorb expansion and contraction in gas connections on a heat treating furnace



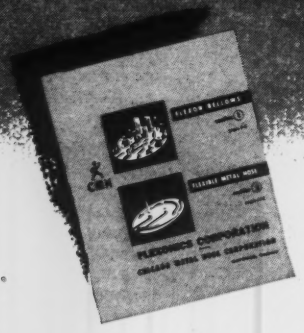
SOLUTION:

Use lengths of CMH REX-WELD Flexible Metal Hose . . .

The problem of making connections that stay tight under conditions of expansion and contraction are easily solved with CMH REX-WELD Flexible Metal Hose. Take the case of the furnace illustrated above—when it is brought up to temperature, the gas burners expand. Rigid connections would be put under severe strain with serious danger of failure. Short lengths of REX-WELD inserted in the lines safely absorb this expansion.

CMH REX-WELD is corrugated flexible metal hose in steel or bronze. It is available in sizes 3/16″ to 24″ I. D., metal braid covered or unbraided. Depending on size and material it is suitable for burst pressures to 12,000 psi., temperatures to 1000° F. Stainless steel types are also available.

For recommendations, write, outlining the nature of your problem.



Design Guide No. 123 gives full details on REX-WELD as well as other types of CMH Flexible Metal Hose and Flexon Bellows. Write for your copy today.

Flexon identifies CMH products that have served industry for over 50 years.

CMH

CHICAGO METAL HOSE Division

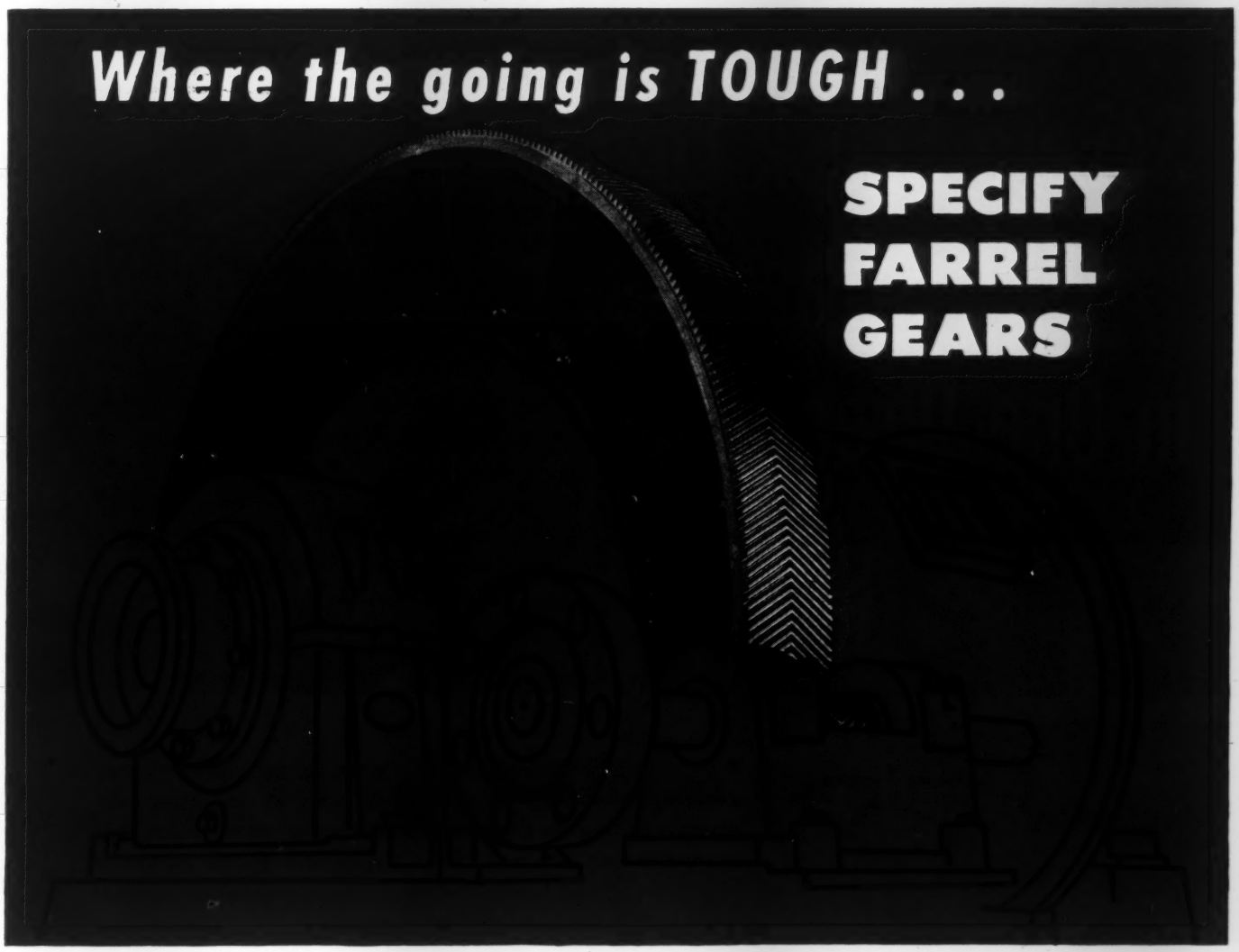
Flexonics Corporation

1339 S. Third Avenue · Maywood, Illinois

Manufacturers of Convoluted and Corrugated Flexible Metal Hose in a Variety of Metals • Expansion Joints for Piping Systems • Stainless Steel and Brass Bellows • Flexible Metal Conduit and Armor • Assemblies of These Components

In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario

Where the going is TOUGH . . .



SPECIFY FARREL GEARS

Precision generation combined with the use of highest grade materials gives Farrel herringbone gears the ability to withstand the heaviest shock loads encountered in machine applications.

Accuracy of tooth contour and tooth spacing, overlap or interlacing of the teeth, gradual engagement and inclined line of pressure contribute to smooth operation and maintenance of correct tooth action throughout a long gear life. The opposed helices balance and absorb axial thrust within the gear member, preventing harmful thrust loads with resultant stresses on other parts of the machinery.

Farrel engineers are available to assist in working out unusual gear problems. Information about herringbone gears, or any of the other types mentioned on this page, will be sent on request.

FARREL-BIRMINGHAM COMPANY, INC., ANSONIA, CONN.

Plants: Ansonia and Derby, Conn., Buffalo, N. Y.

Sales Offices: Ansonia, Buffalo, New York, Boston, Pittsburgh, Akron, Detroit, Chicago, Minneapolis, Portland (Oregon), Los Angeles, Salt Lake City, Tulsa, Houston, New Orleans

Farrel-Birmingham®

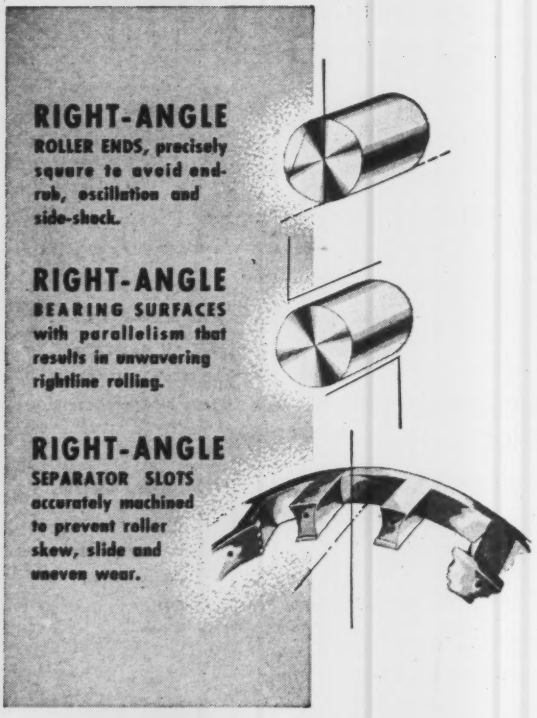
FB-734

HERRINGBONE GEARS
Farrel-Sykes herringbone gears are available in any size from ¼ inch to 20 feet diameter, ¼ to 60 inch face, 24 DP to 0.75 DP.

STRAIGHT TOOTH AND SINGLE HELICAL GEARS
Farrel also supplies straight tooth (spur) gears and single helical gears in any size from ¼ inch to 20 feet diameter, ¼ to 30 inch face, 24 DP to 0.5 DP.

INTERNAL GEARS
Large internal gears are available with either spur or helical teeth, in sizes up to 18 feet diameter, 12 inch face, 1¼ DP.

Severe Shock Loads With Stress in One Direction



• Drop forges, various types of presses, headers, breakers and crushing machinery impose shock loads in one direction, severely testing the capacity of a bearing to resist fatigue and permanent set. Rollway Solid Cylindrical Roller Bearings afford the elastic limits and the high fatigue values to take these highly localized stresses in stride.

That's because Rollways are *made right.* They provide more metal to carry the load . . . maintain long line contact with the race.

Right-angle loading reduces unit pressures. Right-angle trueness reduces wear, heat, noise.

Our Complete engineering and metallurgical services will gladly work with you on your problems. Simply write or wire any sales office. No cost. No obligation. Rollway Bearing Co., Inc., Syracuse, N.Y.

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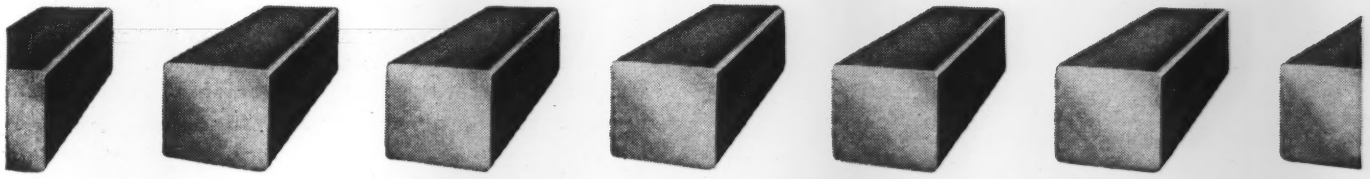
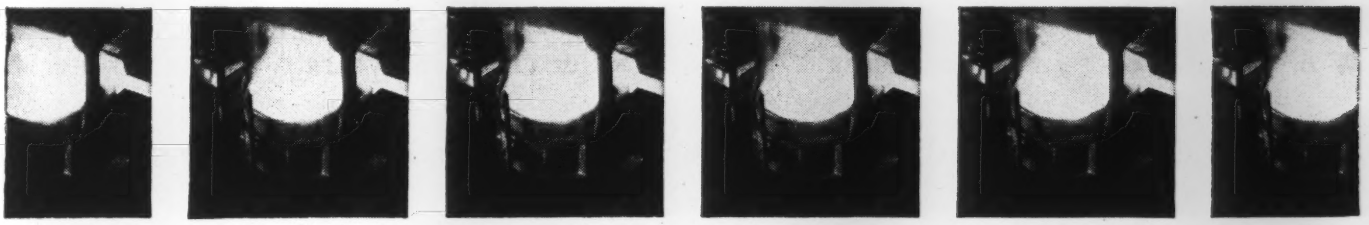
ROLLWAY BEARINGS

Complete Line of Radial and Thrust Cylindrical Roller Bearings

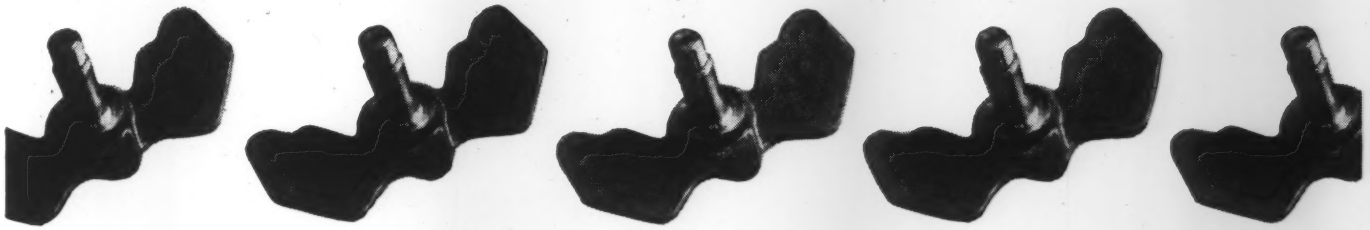
Because TIMKEN® forging steels are uniform from bar to bar...



and from heat to heat...



you get uniform forgings!



YOU can be sure of uniformity from bar to bar and heat to heat when you use Timken® forging steels. That's because the quality of Timken forging steels is rigidly controlled from melt shop through final inspection by the most precise methods known.

Because every analysis of Timken forging steel has uniform forgeability, with superior surface and internal quality, you get better and more uniform finished products. Rejects, delays and changes in shop practice are reduced.

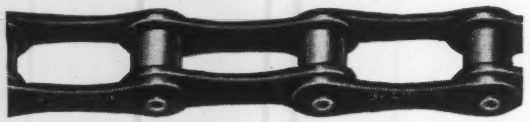
For help in cutting your forging production costs, consult our Technical Staff. Write us today for our "Technical Bulletin, No. 31". The Timken Roller Bearing Company, Steel and Tube Division, Canton 6, Ohio. Cable address: "TIMROSCO".

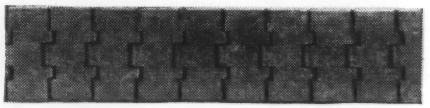
YEARS AHEAD—THROUGH EXPERIENCE AND RESEARCH

SPECIALISTS IN FINE ALLOY STEELS, GRAPHITIC TOOL STEELS AND SEAMLESS TUBING

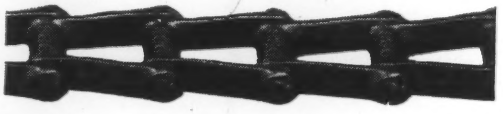
Why take it for

We don't know the reason, but somehow chains seem to be taken for granted. If a chain for driving, timing or conveying has operated reasonably efficiently, that same chain is specified year after year. Yet, case after case shows that important savings can be made if these important functions are viewed with an eye for cost reduction and improved performance. For example:

● A manufacturer had been using a standard roller chain for years on his machine. A Rex Field Sales Engineer showed him that he could use a Baldwin-Rex Double Pitch Roller Chain  and get the same operating efficiency at a substantial reduction in cost because speeds did not require standard roller chain.

● Another manufacturer had been using conventional flat top chain to carry cans through his machine. It was necessary to pay a premium for special bevel top plates to avoid tipping of cans. By switching to Rex TableTop®  he got even smoother tip-free operation at far lower cost.

● A business machine manufacturer, faced with the need for more accurate timing, consulted his Rex Field Sales Engineer and switched from leather belts to the smallest roller chain—¼-inch pitch Baldwin-Rex No. 25 —and accomplished his objectives.

● In carrying material through a scalder, a manufacturer had been using conventional steel chain. By switching to Rex Cast Pintle Chain,  he not only cut his costs but the chain lasted far longer.

What's Your Problem?

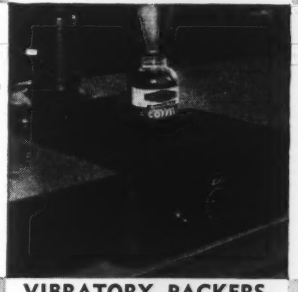
BIN VIBRATORS

VIBRATORY FEEDERS

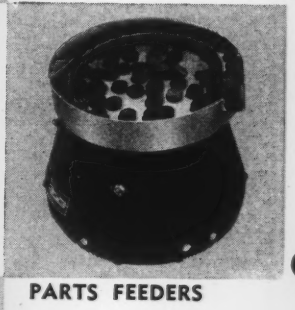
Clogged bins and hoppers? Slow, unreliable, uncontrolled material feed? Lack of sizing or separation? Does the product require settling or packing down in containers? Are you fumbling around with small parts? Inefficient industrial heating methods that are costly to operate and maintain? Difficulties with current conversion? Leaky shafts? Slow, laborious hand batching?

'IBRATING GRIZZLIES

VIBRATING SCREENS



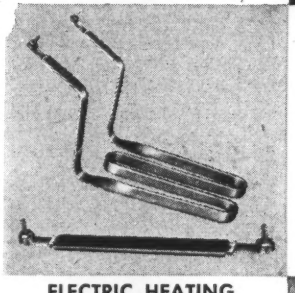
VIBRATORY PACKERS



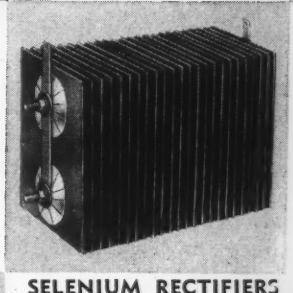
PARTS FEEDERS

Then ask about—

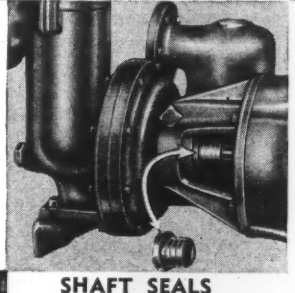
SYNTRON



ELECTRIC HEATING ELEMENTS



SELENIUM RECTIFIERS



SHAFT SEALS

ELECTRIC VIBRATORS, promoting free-flowing bins, hoppers and chutes.

VIBRATORY FEEDERS, controlling the flow of materials in packaging machines, etc.

VIBRATORY PACKERS, settling materials in containers and molds.

PARTS FEEDERS, feeding small objects to automatic machinery, machine tools, etc.

VIBRATING GRIZZLIES, for rough scalping.

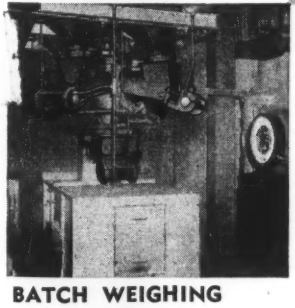
VIBRATING SCREENS, removing foreign objects, lumps, etc.

SHAFT SEALS to eliminate leakage of gases and liquids.

BATCH WEIGH SYSTEMS, with scale-controlled Feeders and Vibrators.

ELECTRIC HEATING ELEMENTS, thin, flat, sheathed with extremely uniform heat distribution.

SELENIUM RECTIFIERS for efficient conversion of AC to DC.

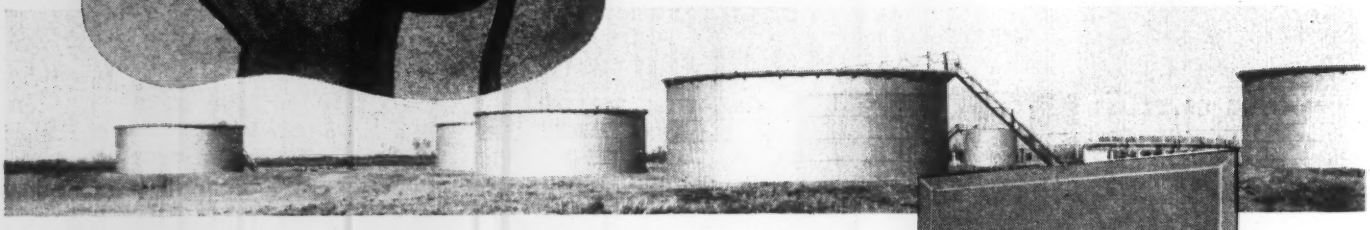


BATCH WEIGHING

SYNTRON CO.

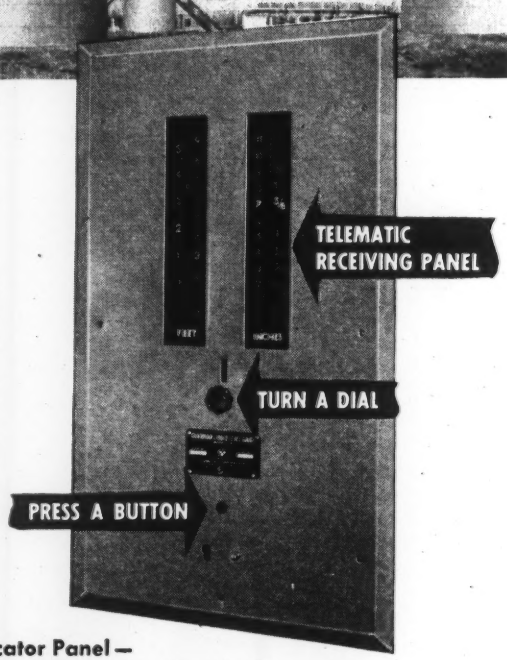
260 Lexington, Homer City, Pa.

for MARINE COMMUNICATIONS or TANK GAUGING

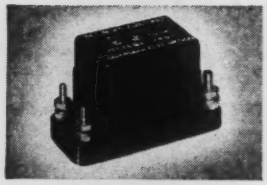


Relays BY GUARDIAN

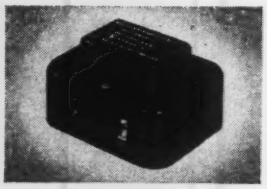
Leading manufacturers of marine radio equipment specify Guardian Controls for high efficiency handling of military ship to ship and ship to shore communications. Perfected through twenty years of development and use in commercial travel ships and warcraft, Guardian controls have served so faithfully in marine radios that they've justified their selection for a wide variety of intricate applications. For example, Guardian Controls have been used *exclusively* over more than fourteen years to transmit and receive remote readings on Telematic Liquid Level gauge systems. At the touch of a button, instantaneous readings of remote storage tank levels appear on the indicator panel in the control room. Leading pipeline companies and oil refineries report not a single service call since original installations made more than fourteen years ago. Let Guardian Controls serve you . . . *just as well!*



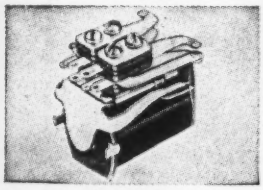
Telematic Indicator Panel — Telematic Corporation — Chicago 13, Ill.



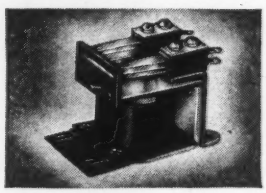
AN-3320-1 D.C.



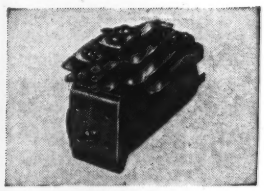
AN-3324-1 D.C.



Series 595 D.C.



Series 610 A.C.—615 D.C.



Series 695 D.C.

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HELPFUL LITERATURE

FOR DESIGN EXECUTIVES

84. Three-Dimensional Microscopes

Bausch & Lomb Optical Co.—Series 14 three-dimensional microscopes are subject of 20-page illustrated catalog "Stereomicroscopes." In addition to their use in quality control and research work, these instruments are employed for assembly and inspection operations. Reflector, illuminator and elliptical mirror types of illuminators are also described.

85. Metal Conveyor Belts

Ashworth Bros. Inc., Metal Products Div.—44-page brochure entitled "Metal Conveyor Belts" illustrates myriad of typical installations of woven metal conveyor belts along with basic technical information needed for proper belt selection. Weave designs with mesh, wire size, opening and weight data is also featured, as well as chain drive and belt edge construction.

86. Practical Dimensioning Techniques

Gisholt Machine Co.—Fundamentals of dimensioning engineering drawings are covered in detail in this 40-page, well-illustrated manual "Practical Dimensioning," by E. C. Helmke. Designated as form 1160, it points out that poor dimensioning practice can add tremendously to product cost and that good practice consists of avoiding the accumulation of tolerances. Text makes use of 26 drawings.

87. Sprockets & Roller Chain

Cullman Wheel Co.—How semi-stock sprockets and roller chain adapt themselves readily to mechanical power transmission applications is related in 12-page illustrated bulletin. Dimensions and list prices are given for various sizes of semi-stock sprockets, welded hubs, hub centrals, keyways and set screws as well as on single and multiple roller chain.

88. Electrical Connectors

Cannon Electric Co.—Bulletins L85-1951 and GB4-1951 deal with laboratory and switchboard, and battery connectors respectively. First describes plugs and connectors for use in laboratory, testing, switchboard and experimental operations, and latter covers battery connectors for engine starting, to simplify battery change or replacement, and for general uses.

89. Uses of Laminated Plastics

Richardson Co.—20-page illustrated catalog "Laminated Insurok" explains advantages offered by laminated plastics and shows their applications in mechanical and electrical products. Mechanical and electrical properties of various laminates are tabulated. Also listed are NEMA tolerance data on laminated sheets, rods and tubes. Suggested procedures for fabricating parts from material are included.

90. Hard Rubber & Plastics

American Hard Rubber Co.—Between plastic-bound covers of this 6 x 9-in. "Ace Hard Rubber & Plastics Handbook" are six sections on hard rubber, special hard rubber compounds, impact resistant resin-rubber blends, Ace-Tex Pyrobitumen, coverings and lining of hard and soft rubber, and thermoplastic materials. Properties, selection, tolerances and applications are detailed.

91. Long-Wearing Machinery Parts

Haynes Stellite Co.—Variety of cast and wrought alloy parts used to solve abrasion, corrosion and high temperature problems is described in illustrated 24-page booklet "Long-Wearing Machinery Parts." Over 60 blueprints, tables and photos are included. Much design information is presented.

92. Timers

Dimco-Gray Corp.—Five illustrated 2-page data sheets outline features of universal, interval and micro timers for all types of inspection, testing and production operations. These synchronous electric devices are available with ranges to suit practically any need.

93. Sheet Counting & Marking

Counter & Control Corp.—4-page illustrated bulletin 401 gives details of automatic electric sheet counting and marking machines and equipment for printers, lithographers, paper mills, die cutters and box plants.

94. Unicellular Plastic

Sponge Rubber Products Co.—Buoyancy, insulation and structural rigidity are properties of Spongex unicellular polyvinyl chloride plastic, described and illustrated in 4-page data folder. Chemical resistance and special properties are covered. Material is offered in extra soft, soft, medium and hard grades.

95. Electric Motors

Wagner Electric Corp. — 4-page illustrated bulletin MU-94 No. 19 shows construction features of type RA general-purpose repulsion-start induction motors. Locations of branch offices which offer engineering aid are listed.

96. Finned Tubing

Bush Mfg. Co.—Besides illustrations of various types of finned tubing, data sheet gives detailed specifications for the tubing which should be of considerable value to designers.

97. Rotary Switches

Electro Switch Corp.—Type JR rotary switch for centralized control, multipole tap switching and simplified control of complex circuits is described and illustrated in 8-page catalog 1950-JR, one of two catalogs in brochure. Other catalog, 1951-P, covers type P rotary switches for every control and transfer application. All necessary information required by designers is included.

98. Welding Information

Eutectic Welding Alloys Corp.—Enlarged to 72 pages, fourth edition of "Manual of Welding Design and Engineering" contains 62 new photos and 132 new drawings together with latest data and how-to-do-it articles. Weld diagrams and tables on melting temperatures, tensile strengths, corrosion factors, etc., are featured as well as data on 100 low temperature welding alloys for various metals.

99. Reversing Transmission

Snow-Nabstedt Gear Corp.—Brief description is offered in data sheet No. 5107 on a reversing transmission designed for materials handling equipment, light road construction equipment, trucks, etc. Clutch has 3.75:1 reduction in both directions and 2 to 12-hp transmission.

FOR MORE INFORMATION

on developments in "New Parts" and "Engineering Department" sections—or if "Helpful Literature" is desired—circle corresponding numbers on either card below

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100. Electrical Insulation

Dow Corning Corp.—Series of five issues of "Silicone Notes" covers properties and applications of class H electrical insulation. Listed are leading manufacturers and suppliers of class H components made with Dow Corning silicones. Included is property and specification sheet for silicone-varnished glass cloth and tape.

101. Tracing Cloth

Charles Bruning Co.—Data sheet A-2029 is descriptive of Brutex No. 378 white tracing cloth which retains its translucency, color, flexibility and drawing surface for many years. Product is not affected by perspiration or dampness.

102. Electric Insulating Materials

General Electric Co., Chemical Div.—Properties and applications of various types of GE electric insulating materials are covered in illustrated bulletin CDL-35. Included are varnishes, Glyptal alkyd resin insulating finishes, varnished cloths and tapes, sealing and filling compounds and silicone materials.

103. General-Purpose Pumps

Allis-Chalmers Mfg. Co.—"Type SSB General-Purpose Pumps" is title of 6-page illustrated folder 52B6351B which contains design and application data on these grease-lubricated pedestal-mounted pumps which are available in capacities to 2500 gpm at heads to 550 ft and temperatures to 250° F.

104. Air Line Valves

Hannifin Corp.—8-page highly illustrated bulletin 231 which opens up into large wall chart is descriptive of line of 2-way, 3-way and 4-way Pilot Master valves for air pressures up to 150 psi. Large cutaway drawing shows 13 design features. Suggestions on where to use valves are presented along with model and pipe sizes.

105. Ring Packing

Greene Tweed & Co.—Design features, operational data, installation procedures and suggested dimensions pertinent to Palmetto G-T ring, a packing used successfully at 15,000 psi without extruding, are given in 8-page illustrated bulletin MP-68. Packing is recommended for use as seals in hydraulic and pneumatic cylinders and valves, welding machine, steering gears and testing equipment.

106. Aluminum Protection

American Chemical Paint Co.—Facts pertinent to, and advantages of Brush Alodine, a coating designed to protect both painted and unpainted aluminum, are given in 6-page folder 690. Product can be applied by brush or spraying.

107. Socket Cap Screws

Holo-Krome Screw Corp.—Pocket-sized 4-page folder on flat head socket cap screws contains brief listing of sizes available as standard. It also gives information on features and laboratory testing methods by which screws are checked.

108. Gear Hobs

Michigan Tool Co.—Applications of precision ground, class B ground, accurate unground and roughing hobs in the production of gears and splines are cited in 4-page illustrated bulletin H-52. Table of tolerances of various types of hobs is given as guide to selection and application.

109. Tool & Die Steel Guide

Carpenter Steel Co.—"A Simplified Guide for Spark Testing Tool and Die Steels" is title of 20-page illustrated booklet designed to help in checking identity of tool and die steels. It features diagrams of 13 standard steels with descriptive matter giving spark characteristics for each. Instructions for dressing grinding wheel and preparing steel samples are included.

110. Electrical Breakaway Coupling

E. B. Wiggins Oil Tool Co.—Five principle features of Wiggins electrical breakaway coupling which can be connected or disconnected without a wrench are outlined with brief description of each in 4-page folder entitled "Versatile."

111. Air Valves

Beckett-Harcum Co.—Design and operating features of Hi-Cyclic air valves are included in 8-page illustrated bulletin 10A. Engineering drawings and specifications of each are given. Valves control air cylinder stroke within 0.001-in., reciprocate mechanically or electrically, and stop and return stroke at any point.

112. V-Belt Catalog

Boston Woven Hose & Rubber Co.—128-page replacement catalog on Bull Dog V-belts for appliances, light industrial equipment and other drives contains four listings: Section 1, interchangeability list which compares Bull Dog belt numbers to those of other manufacturers; Section 2, an alphabetical list of machines using belts; Section 3, a numerical list of belt number and size with machines it will fit; and Section 4, a belt dimension and weight list.

113. Hydraulic Gear Pumps

Hydraulic Equipment Co.—Illustrations, dimensions and performance data on various types of flange and foot-mounted reversible rotation oil hydraulic gear pumps are found in data sheets 128 and 129. The 2000 series pumps have capacities from 13 to 25 gpm at 1200 rpm and 1500 psi.

114. Small Tools

Brown & Sharpe Mfg. Co.—The 224-pages of No. 35 catalog presents complete line of small tools. Included are machinists' tools, electronic measuring equipment, gages, Johansson gage blocks, milling cutters, hobs, arbors, adapters and collets, screw machine tools, pumps, ground flat stock, vises and magnetic chucks. Details of each are given.

115. Metal Powder Bearings

Wel-Met Co.—Listed in 4-page folder No. 104 are 133 MPA standard self-lubricating bearing sizes, their ID, OD and length, as well as corresponding part numbers of interchangeable bearings produced by Wel-Met and five other American bearing manufacturers. It is punched for catalog binders.

116. Drafting Machine Scales

Universal Drafting Machine Corp.—Information on advantages of Duraline drafting machine scales, made of aluminum and ground from the solid, is to be found in this illustrated bulletin. Three-quarter size photos show standard scale graduations used by engineers, draftsmen, architects and designers.

117. Alloy Steel Tubing

Babcock & Wilcox Tube Co.—Problems involving use of alternate grades of low carbon or carburizing grades of tubing steels can be solved by reference to 4-page bulletin TDC 149. It offers condensed data on microstructure, critical points, effect of alloy elements, forging, machining, welding and thermal treatment.

118. Aluminum Data

Reynolds Metals Co.—All technical literature and moving pictures available to designers and engineers are listed in 6-page folder "Literature & Movie Index". Literature is offered on design, fabrication, application, products and general information on aluminum and how to use it most effectively.

119. Small Pumps

Tuthill Pump Co.—"Tuthill Pump Guide" is reference chart on small pump applications. Listed are available types of pumps, services for which each is built, performance characteristics, types of packings, styles of mounting and features.

120. Selection of Engineering Irons

International Nickel Co.—28-page basic reference bulletin "Guide to the Selection of Engineering Irons," compiled for design engineers, presents characteristics of nickel cast irons. Included are 27 tabels, charts and photomicrographs that show use of nickel, alone or in combination with alloying elements.

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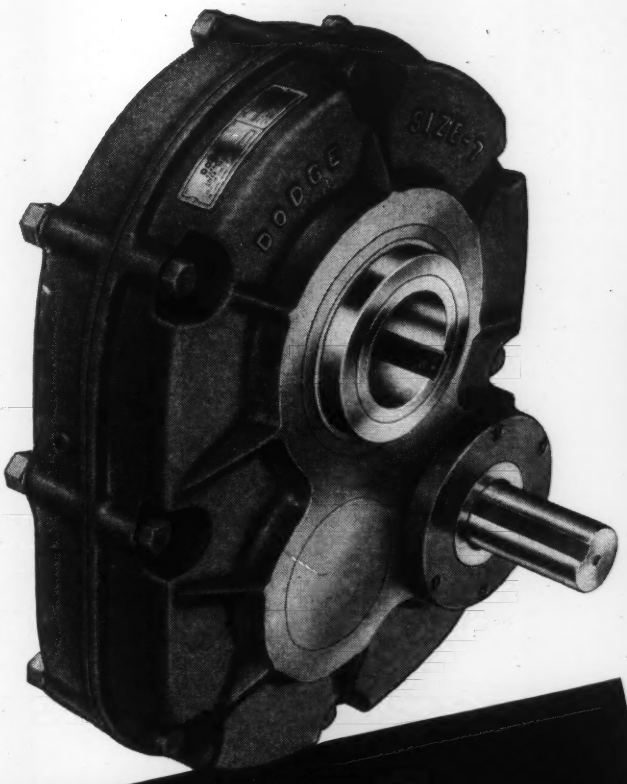

A NEW SIZE!

43 H.P.

DODGE TORQUE-ARM

The Speed Reducer that saves you real money!

Here it is—the big size that enthusiastic Torque-Arm users have been asking for! Engineered for the same dependable performance and same economy that have made Dodge Torque-Arm Speed Reducers a nation-wide sensation.

- The new "big brother" of the famous Torque-Arm family. Double reduction. 43 hp capacity. Output speeds from 12 to 110 rpm.
- Rugged. Dependable. *Economical.* No special engineering required. No foundation to provide. No flexible couplings. No "lining up" difficulties. No expensive installation.
- Stock TAPER-LOCK sheaves prescribed for each job provide desired speeds. Application to other machines is practical and easy.
- Unit is driven through any V-belt drive. A torque arm, fastened to any fixed object, anchors the reducer unit. Turnbuckle provides fast and accurate adjustment of belt tension.
- Backstop available from stock when required. Easily installed. Sealed and lubricated inside reducer housing.
- Dodge Tri-Matic Overload Release, which provides positive protection for driven machines both mechanically and electrically, is available from stock.
- Dodge Torque-Arm Speed Reducers are built in two series—Single and Double Reduction. Eleven sizes in all, with capacities from 1 to 43 hp and output speeds from 13 to 333 rpm. All available from distributors' stocks.
- WRITE for special Torque-Arm bulletin.

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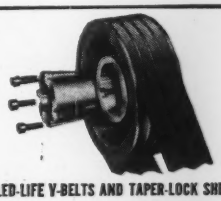
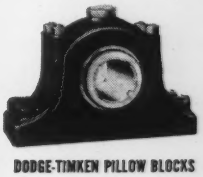
CALL THE TRANSMISSIONEER, your local Dodge Distributor. Factory trained by Dodge, he can give you valuable assistance on new cost-saving methods. Look for his name under "Power Transmission Equipment" in your classified phone book.



SEALED-LIFE V-BELTS AND TAPER-LOCK SHEAVES



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SOLID STEEL CONVEYOR PULLEYS

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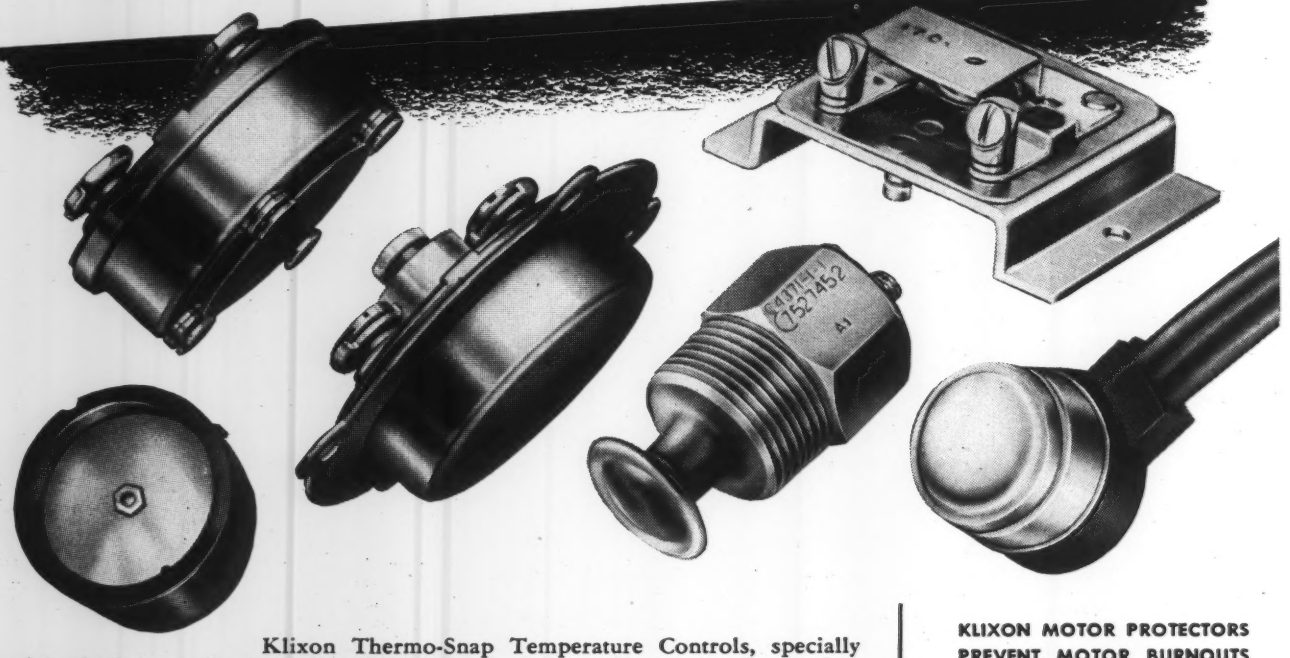
FOR TANKS OR UNIT HEATERS

KLIXON *Thermo-Snap* CONTROLS

Provide Accurate Temperature Control



Klixon Thermo-Snap Temperature Controls, specially designed for built-in application, give you accurate control usually at a lower cost than expensive general purpose controls.

Actuated by the simple Spencer Disc, these controls have nothing to get out of adjustment or wear out. The "snap-action" of this Spencer Disc "opens" the circuit with a quick, clean break . . . "closes" the circuit to a solid make.

Klixon Thermo-Snap Controls are used in military and civilian products in such applications as electric heaters, gas heaters, oil heaters for fan switches and high limit shut-offs . . . in tank, aircraft, truck and bus heaters for fan and limit switches, fuel delay switches, ignition cutouts . . . in dairy water heaters, soldering guns, melting pots, ironing machines, flat irons for temperature control . . . in radio equipment for tube and rectifier cooling control.

Klixon Thermo-Snap Controls are available in many types and ratings including hermetically sealed units. Our engineers will gladly help you with your temperature control problems. Write for their help and information, today.

Over 50 million Klixon Disc-Type Thermostats in all types of products are giving accurate performance.

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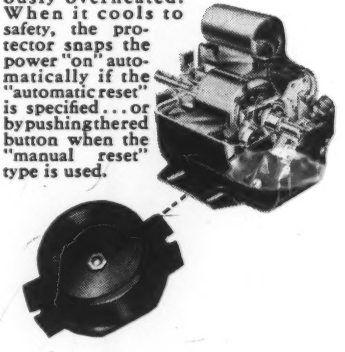
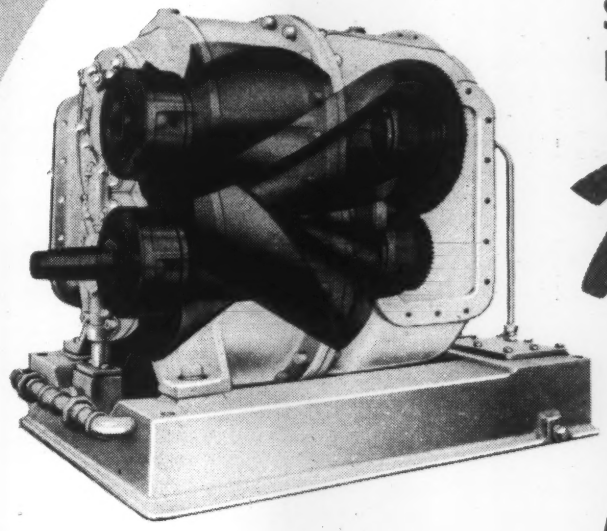
KLIXON MOTOR PROTECTORS PREVENT MOTOR BURNOUTS

To keep motors operating longer, specify and use motors with built-in Klixon Protectors. Built-in by the motor manufacturers, they prevent motor burnouts by cutting "off" the power should the motor become dangerously overheated. When it cools to safety, the protector snaps the power "on" automatically if the "automatic reset" is specified . . . or by pushing the red button when the "manual reset" type is used.

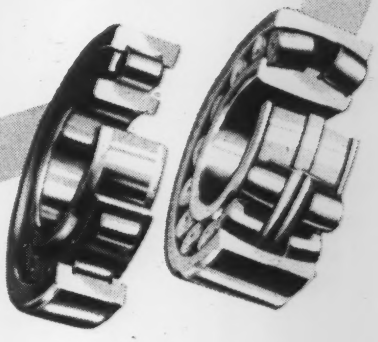




STANDARDAIRE BLOWER DESIGN

Plus

SKF BEARING ENGINEERING



Every so often, a manufacturer has a chance to *prove* his wisdom in the selection of the product components he specifies.

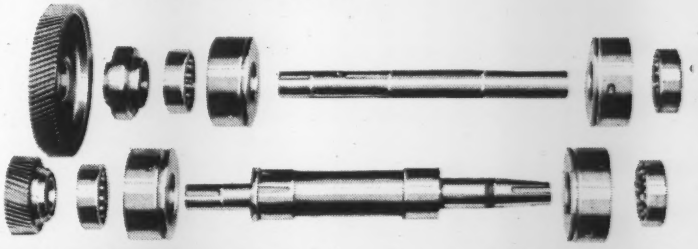
For example, Read Standard Corporation was able to obtain performance data on one of their "Standardaire" Blowers which had operated 24 hours a day, for 15 months, at 2200 rpm.

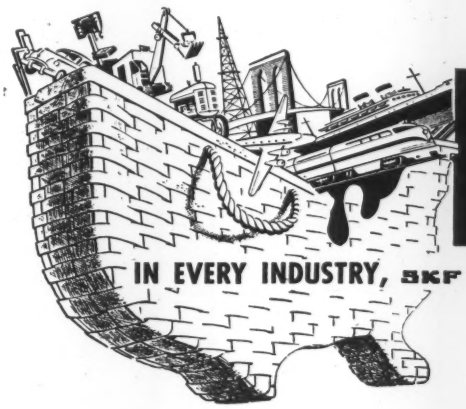
In other figures, that's about one and a half billion revolutions—representing many years' service for typical blower installations.

Even after the hard, difficult service, this blower and bearings were found to be in excellent condition when dismantled and inspected in the presence of Read Standard customer's representative.

Performance like this is proof of sound *design*—proof, too, that the designers selected the best available materials and component parts . . . among these were SKF Bearings.

Here we quote from the "Standardaire" Blower performance report: "Anti-friction bearings in good condition." They were SKF Cylindrical, and Spherical Roller Bearings, designed into the gate rotor shaft and main rotor shaft as shown in the illustration.





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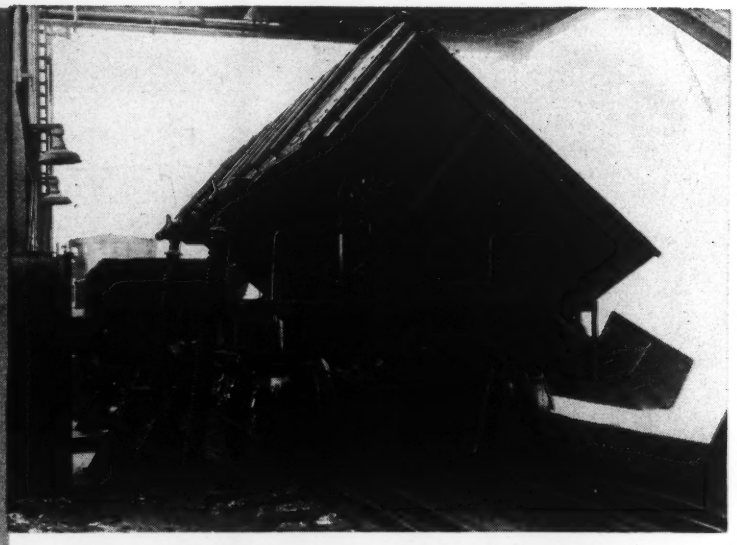
BALL AND ROLLER BEARINGS

Remember—if you want design assistance and engineering help when you're laying-in bearings, you can get it from SKF field or home office men who know the best ways to do the job in every industry. **SKF INDUSTRIES, INC.,** PHILADELPHIA 32, PA.—*manufacturers of* **SKF** *and* HESS-BRIGHT *bearings.*

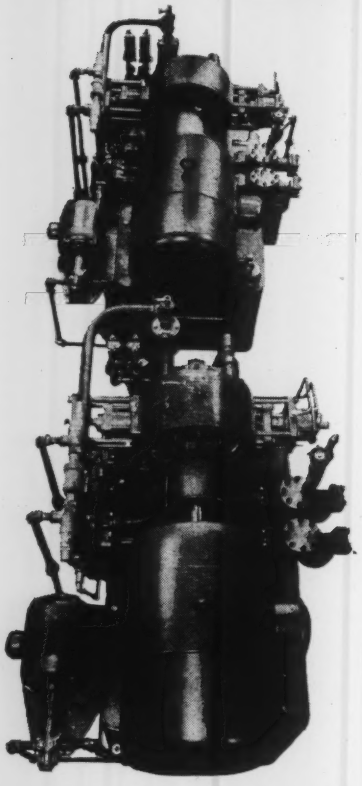
7323

Lassman

HEAVY DUTY HYDRAULIC EQUIPMENT *in Action* at the NEW J&L OPEN HEARTH SLAG DISPOSAL DOCK



Dumping a slag car at the J&L Slag Disposal Dock. When lowered the Jacks fit into cam pedestals to provide locomotive clearance.



The two motor-driven Hydraulic Pump Units, each controlling one of the two Hydraulic Jacks. Both pump units are synchronized to insure simultaneous operation of both Jacks at equal speeds in both directions of motion.

The new Open Hearth Slag Disposal Dock on the South Side of Pittsburgh provides Jones and Laughlin Steel Corporation with a modern, efficient and time saving method of disposing of Slag from the Open Hearth Department.

The new facilities were devised by J&L's Engineers. The complete electro-hydraulic system, including the Jack Cylinders, was designed and built by Benjamin Lassman and Son.

Each Hydraulic Jack Cylinder is served by its individual motor-driven Hydraulic Pump Unit. Both Pump Units are synchronized to insure simultaneous functioning of the two Hydraulic Jack Cylinders at equal speeds in both directions of motion.

Operation of the entire equipment is by means of two Push Buttons . . . one for tilting . . . the other for returning . . . so that only one operator is needed for dumping the Slag.

After the Car is "spotted" only two minutes are required for the dumping and returning of the Car.

You can depend upon Lassman Heavy Duty Cylinders. They are custom-made for each individual job. When your requirements call for heavy duty, high-pressure Hydraulic Cylinders that must stand up under continuous service, Lassman Cylinders offer the "extra" features essential to such applications.

BENJAMIN LASSMAN & SON

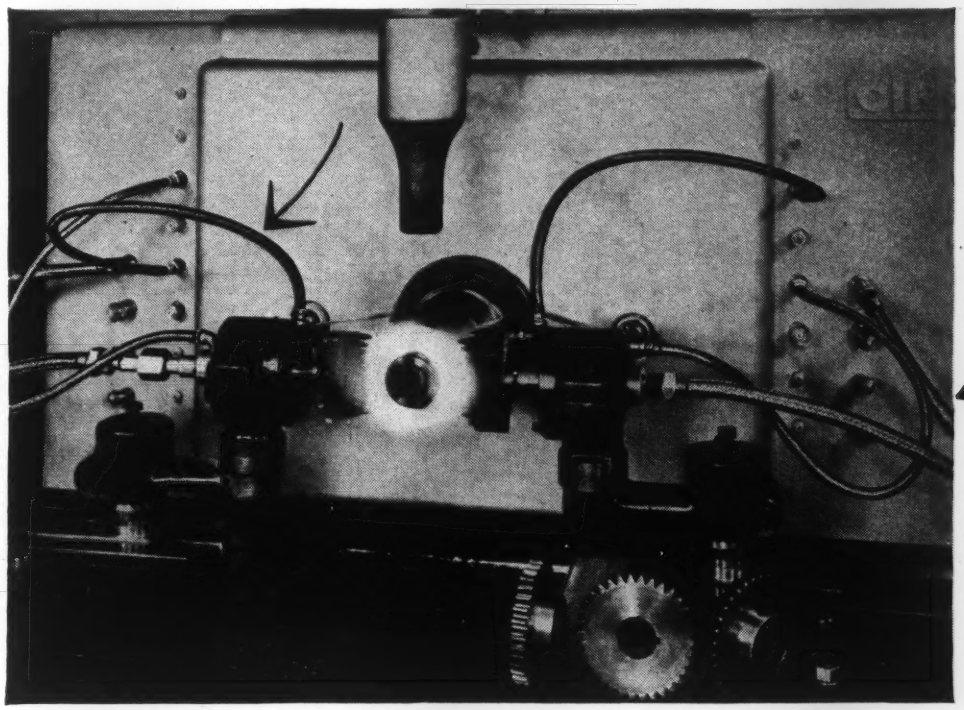
ENGINEERS & MANUFACTURERS SINCE 1921

421 OLIVER BUILDING PITTSBURGH 22, PA.

HIGH PRESSURE HYDRAULIC EQUIPMENT . . . APPLICATION & DESIGN.

CONTACT THE FOLLOWING REPRESENTATIVES: Amherst, Mass., James H. Stewart, Harkness Road • Bell, Calif., Paul-Munroe Company, *Phone: Los Angeles, Jefferson 5227* • Birmingham 1, Ala., Chas. F. Wheelock & Associates, *Phone: 4-6283* • Buffalo 7, N. Y., Lane Engineering Co., *Phone: Riverside 0770* • Cleveland 11, O., N. R. Fisher, *Phone: Winton 1-0597* • Detroit 15, Mich., Industrial Air & Hydraulic Equipment Co., *Phone: Valley 2-3994* • Independence, Mo., L. H. Monsees, *Phone: Clifton 8520.*

What kind of work does a **Flexible** connector do?



On this electronically controlled Flamatic Hardening Machine, 3/16" I.D. American Flexible Bronze Seamless Tubing connects the water coolant inlet and outlet lines to the adjustable flame heads. Similar ½" I.D. Seamless Tubing conveys gas for the hardening flame.

American Vibration Eliminators isolate compressor line vibration on this truck refrigeration unit installation which was made by The Schnabel Co. of Pittsburgh. Freon gas at 180-200 lb. pressure is carried in the lines.

If connectors must move, absorb vibration, make short bends, connect misaligned ports or make cramped connections, that's the kind of work American Flexible Metal Hose and Seamless Flexible Tubing are designed to do.

They can convey liquids, gas and semisolids under severe conditions of temperature, pressure and corrosion. They supply protective armor for flexible drive shafts, delicate instrument tubing and electrical wiring.

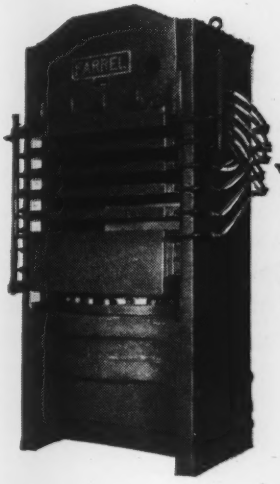
Bulletins SS-50 and CC-300 illustrate the versatility of American Flexible Metal Hose and Seamless Tubing and the many types available. Let us send you copies. The American Brass Company, American Metal Hose Branch, Waterbury 20, Connecticut. In Canada: The Canadian Fairbanks-Morse Company, Ltd.

51243

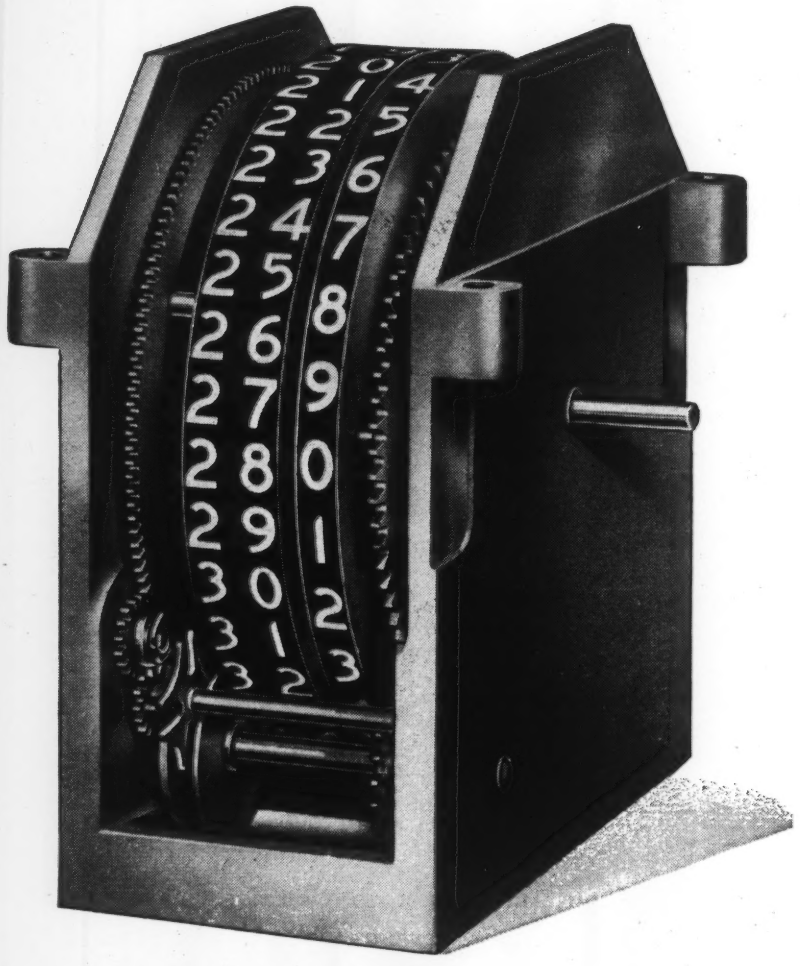
wherever connectors must move . . .

American ANACONDA

FLEXIBLE METAL HOSE AND TUBING



American Bracketubes are used on this Farrel-Birmingham 42" x 42" vulcanizing press to carry steam to the platens.



It helps Gunners to "Bear On" Target

Added Evidence that

Everyone Can Count on VEEDER-ROOT

This is a 360-degree bearing counter . . . equipped with high-speed Geneva transfer and large, readily readable figures . . . which speeds the work and heightens the accuracy of gunnery. And it might well be adapted to bring the same advantages to many other operations in defense work.

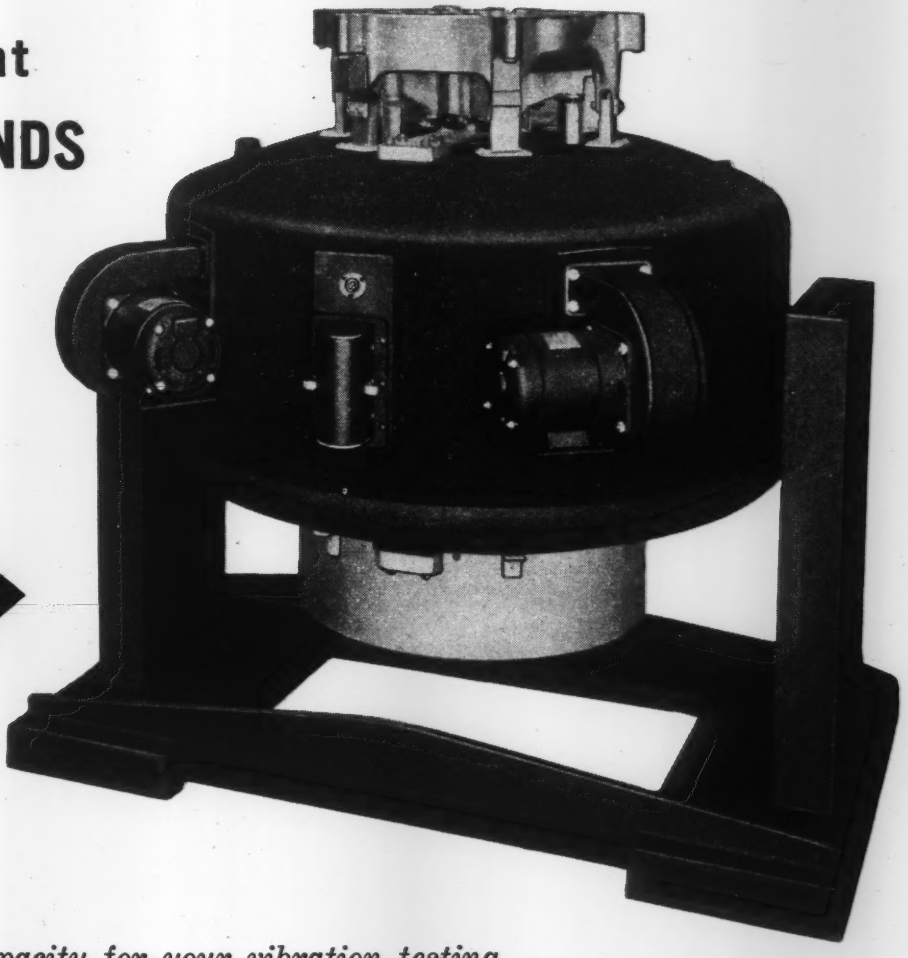
Now if your imagination is stirred by this suggestion, then you can count on Veeder-Root to help you add up to something that will really *count to YOUR advantage.*

VEEDER-ROOT INCORPORATED
"The Name That Counts"
HARTFORD, CONN. • CHICAGO • GREENVILLE, S. C.
Montreal, Canada • Dundee, Scotland
Offices and agents in principal cities

"Counts Everything on Earth"

Big New MB Shaker!

...rated at 2500 POUNDS force



20-inch shake table!

15g at 100 lb table load!

Electrically interlocked control!

No foundation needed!

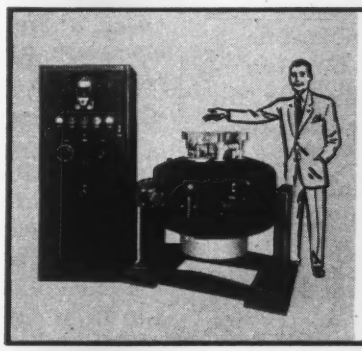
Here's heavy duty capacity for your vibration testing to military specification MIL-E-5272 and 41065-B

Vibration testing reveals *in advance* how your products will behave in service. It's a "must" for military equipment. This new MB model C-25 shaker, one of the largest developed, provides large "brute force" for meeting military vibration testing specifications. Rated at 2500 pounds continuous vector force, it has capacity to produce 15g with 100 lb table load or 20g with 58 lb table load.

An electromagnetic exciter, MB model C-25 features accurate, continuous, easy control of force and frequency. Electrically interlocking controls assure proper operation.

Whether your own vibration testing requirements are of large order or small, you can get the answer to your problem at MB. Models start at 10 pounds force output. Resonant beams for special problems also available.

Make MB *your* headquarters for help and advice on vibration problems. You'll save yourself time and work. ***Write for new Bulletin No. 1-VE-3 on vibration exciters.***

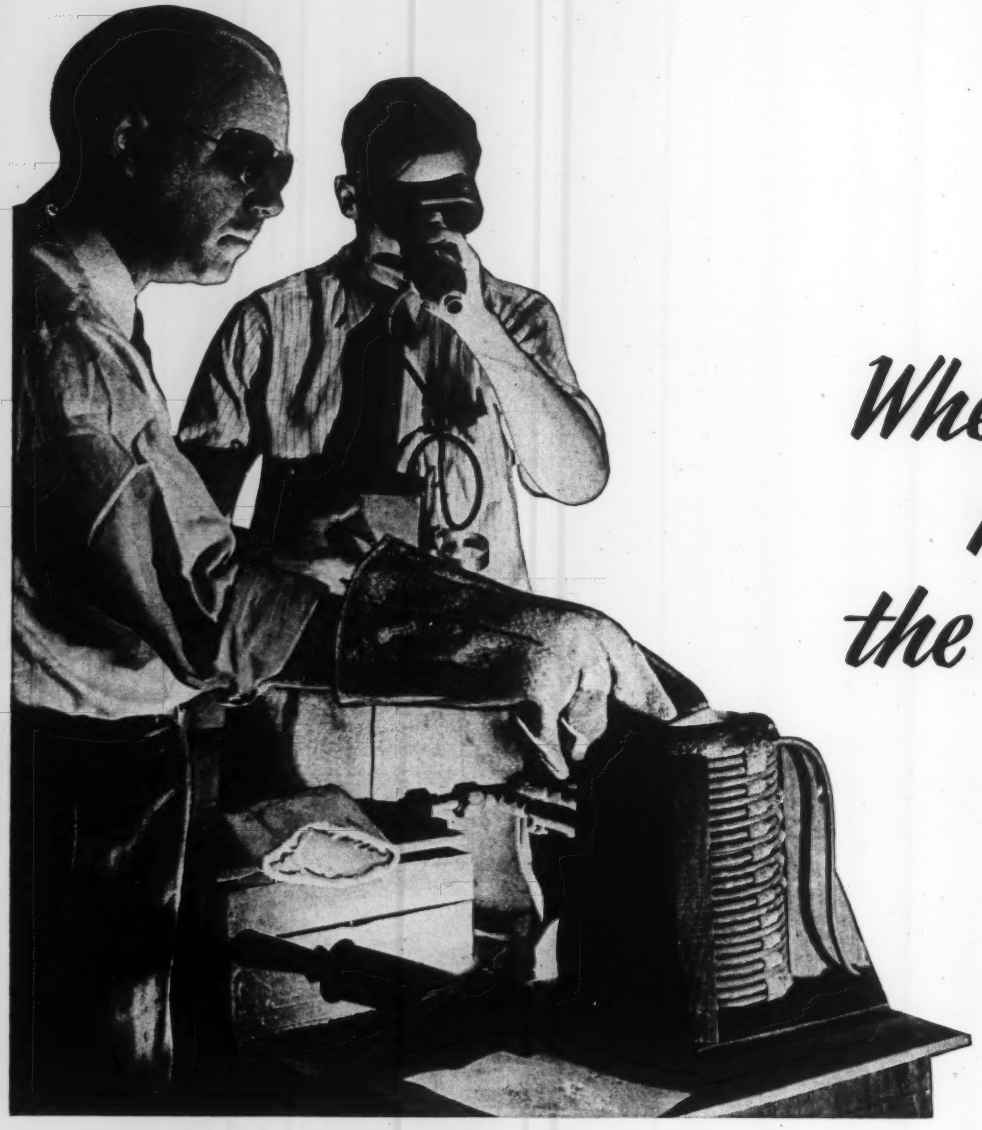


MB's C-25 shaker with control panel. Available with built-in meter to read directly acceleration, velocity or displacement.

THE MB MANUFACTURING COMPANY, Inc.

1060 STATE STREET, NEW HAVEN 11, CONN.

PRODUCTS AND EQUIPMENT TO CONTROL VIBRATION . . . TO MEASURE IT . . . TO REPRODUCE IT



When Nobody Knows the Answer

One of these days you may come face-to-face with a metal problem that does not seem to have an answer.

That is the time to think of these International Nickel Company metallurgists. They are constantly improving and modifying nickel alloys to meet new conditions. They are always ready to help you with specific problems involving metals for aircraft use.

Over the past 50 years, Inco has developed a family of metals for hundreds of different applications. In one branch of the family, for example, is a group of heat-resisting alloys—Inconel®, Inconel "X"®, the Nimonics and Incoloy®— all now important in industry.

Elsewhere on the family tree, you will find other alloys — each with certain special characteristics. Often, there is a better-than-even chance that one of Inco's alloys offers exactly the properties you are looking for.

Of course, this does not mean that somebody at Inco can dip into the files and come up with a pat answer to every new problem. All the answers have not been found yet. But a tremendous amount of research has been done, and you can probably benefit in one way or another from it.

When nobody knows the answer, Inco's metallurgists keep going until they have investigated all possible metals and alloys that might do the job. In fact, the men in Inco's Technical Service (and in their Corrosion Engineering and High Temperature Engineering Services, as well) have one primary goal: to help you determine whether an Inco Nickel Alloy or some *other* metal will serve your purpose best.

No matter what your metal-selection problem may be, all the technical facilities of Inco are available to help you solve it. There is no charge, no obligation of any kind. For prompt technical help whenever you need information about metals, all you have to do is get in touch with: "Technical Service,"

THE INTERNATIONAL NICKEL CO., INC.
67 Wall Street, New York 5, N. Y.

EMBLEM OF SERVICE
NICKEL INCO ALLOYS

MONEL® • "R"® MONEL • "K"® MONEL • "KR"® MONEL
"S"® MONEL • NICKEL • LOW CARBON NICKEL • DURANICKEL®
INCONEL® • INCONEL "X"® • INCOLOY® • NIMONICS

Shining Example of Good Construction

good judgment calls for PARKER-KALON® when good design calls for SOCKET SCREWS

Your INDUSTRIAL SUPPLY DISTRIBUTOR— *your local source for P-K Socket Screws— works side by side with the P-K Assembly Engineer. Their combined efforts are solving many difficult problems of planning and procurement. Let them help you.*

Whether you make simple jigs and fixtures or giant machine tools, assembly with P-K Ground Thread Socket Set Screws will reflect superior construction throughout. Any buyer associates topmost quality with their super-smooth, gleaming *ground thread* finish.

This sales-feature is only one advantage. Assembly moves faster, too. Workers like their clean, burr-free contour, their easy keying, their dependable Class 3 Tolerance.

Ask for samples. See why P-K Ground Thread Socket Set Screws will put your product out in front, assembly-wise and sales-wise. Parker-Kalon Corporation, 200 Varick St., New York 14.

DELIVERIES ARE BETTER, SPECIFY P-K.

SIZE-MARKED CAP SCREWS • GROUND THREAD SET SCREWS • FLAT HEAD CAP SCREWS • STRIPPER BOLTS • PIPE PLUGS • HEX KEYS

Every Man, Woman and Child in the U.S.A. Can Go Riding at the Same Time

IN the U. S. A., competition is basically responsible for better cars at lower comparative cost. We enjoy the use of three times as many cars—and annually produce four times as many cars—as the rest of the world put together. There are approximately 43 million autos—and 9 million trucks and buses—in use in the U. S. A. today. That's more than enough to take everyone riding at the same time.

By stimulating the sale of the new and the resale of the old, our competitive system achieves widespread ownership of automobiles, as with almost everything else. In most foreign countries, out of necessity people make things last as long as possible. In the U. S. A., vigorous competition prompts improvement, refinement and continuous progress. Buyers of new cars get maximum value, because each manufacturer competes actively for the new-car dollar. Lowest-income groups benefit by the lowered prices of used, yet essentially useful, products. Overall result: Steady jobs, good wages and the world's highest standard of living. In most of the rest of the world, luxuries come within reach of only the rich. In the United States, the irresistible drive of competition invents, mass-produces, advertises, distributes and sells—so that most of the miraculous products of modern living are within the reach of all.

Free competition—like freedom of speech, press and religion—is a dynamic part of Uncle Sam's character. Let's keep it free, so that the U. S. A. continues to be the greatest country in the world.

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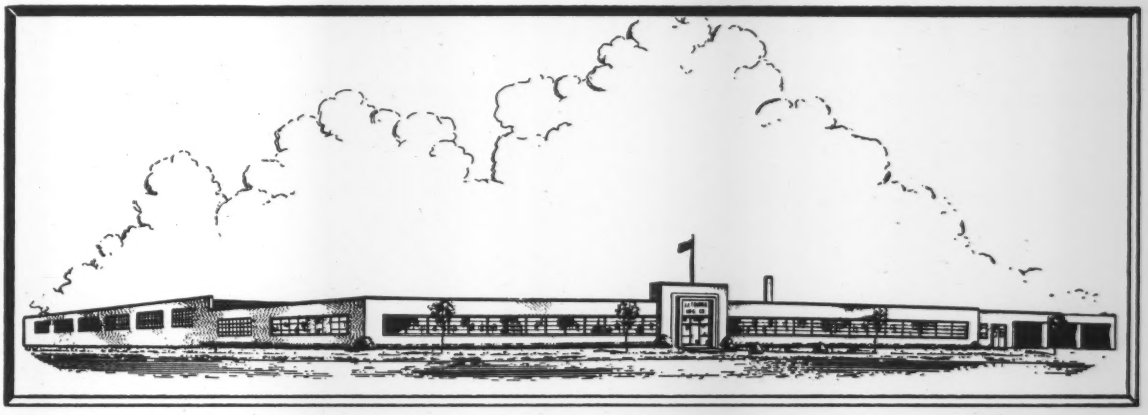
THE COMPETITIVE SYSTEM DELIVERS THE MOST TO THE GREATEST NUMBER OF PEOPLE

— Our New Plant —



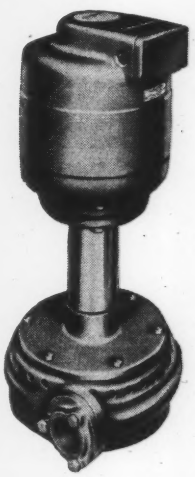
Established 1920
J. J. TOUREK MFG. CO.
"The Best In Quality Screw Machine Products"

The new Tourek plant, shown above in an artist's drawing, will soon be turning out vast quantities of precision screw machine products, ball joints and pipe plugs. All the latest in equipment for producing *"The Best in Quality Screw Machine Products."*

J. J. TOUREK MFG. CO.
4701 W. 16TH ST., CHICAGO 50, ILL.

"I'll say they're

RUTHMAN GUSHER
COOLANT PUMPS



Every Ruthman Gusher Coolant Pump is dynamically balanced to cut vibration to a minimum and reduce costly wear. There is no metal-to-metal contact within the pump. Heavy-duty pre-lubricated ball-bearings require no additional lubrication. Priming and packing are eliminated. Ruthman Gusher Coolant Pumps remain remarkably trouble-free for the life of your machine. Write for our catalog today.

THE RUTHMAN MACHINERY CO.

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free!

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No electric motor manufacturer should be without the practical guidance this up-to-date catalog offers. Send coupon for your free copy of catalog No. 52M.

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PHOENIX ELECTRIC MANUFACTURING CO.
711 West Lake Street Chicago 6, Illinois

Quality controlled Arwood precision castings

When your product needs peak casting performance, take advantage of Arwood's Quality Control.

A typical Arwood Casting for aircraft use is illustrated—tolerances of ±.005 and rigid aircraft specifications are maintained.

Steel die molds assure accurate dimensions and sharp serrations.

Metal soundness is assured by X-ray and Magnaflux controls, physical and chemical certifications.

Arwood Precision Investment Casting is now a tested and important method for producing small intricate parts. It has been the answer to many design and production problems and can be the answer to yours.

For additional information about Precision Castings write Dept. 204 for our new booklet, "Alloy Selection and Design for Investment Castings."

ARWOOD

PRECISION CASTING CORP.

78 WASHINGTON STREET • BROOKLYN 1, N. Y.

Plants: Brooklyn, N. Y., Groton, Conn., Tilton, N. H.

NEW SKINNER SOLENOID VALVE

EXPLOSION PROOF TYPE X5

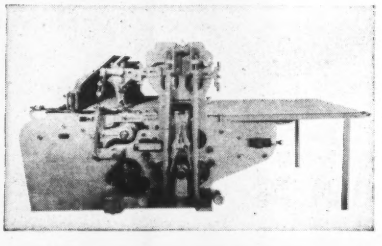
THE new Skinner X5 Solenoid Valve is basically the same as the widely accepted and tested V5, but modified to a construction that is Underwriters' approved for Class I, Group D hazardous locations. Small size and lightweight features are retained, and the X5 is low in price because of the many parts which are interchangeable with other Skinner valves. Rating is 10 watts max.; soft, spring loaded seals prevent leakage; internal parts are stainless steel; wide variety of port locations in ⅛" and ¼" size; most types available for metering; for AC or DC in a wide range of voltages and frequencies; can be mounted in any position; supplied as two-way normally open or closed, three-way normally open, closed or directional flow. *Write today for details!*

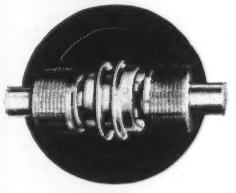
SKINNER ELECTRIC VALVE DIV.

THE SKINNER CHUCK COMPANY

133 Belden Ave., Norwalk, Conn.

This Large Machine Has a





Marshmallow-Light Touch

The Peters Marshmallow Depositor performs numerous light-touch, high-speed operations for the baking industry. It's hopper deposits marshmallow or jelly on base cakes, which are fed continuously. ROCKFORD Pullmore CLUTCHES control the power transmission. Let ROCKFORD clutch engineers help design power transmission control for *your* "light-touch" machines.

ROCKFORD CLUTCH DIVISION BORG-WARNER
311 Catherine Street, Rockford, Illinois, U. S. A.

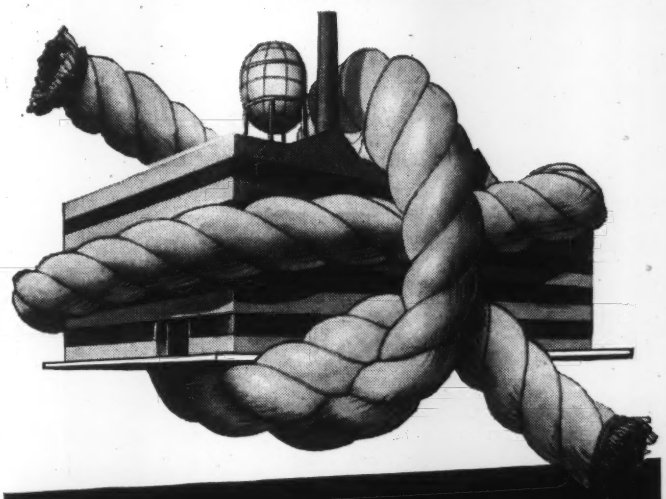
B-W ENGINEERING MAKES IT WORK

B-W PRODUCTION MAKES IT AVAILABLE

ENGINEERING BULLETIN SENT ON REQUEST

ROCKFORD CLUTCHES

ARE YOU ALL TIED UP IN DEFENSE CONTRACTS?



DO YOU WANT TO INCREASE YOUR PRODUCTION FACILITIES?

Pressed Steel Car Company can accept subcontracts for the production of aircraft ground servicing equipment; aircraft and engine component parts; communication equipment; ordnance equipment; structures and component parts; cellular laminated wood products . . . and a wide variety of defense items.

In all, Pressed Steel Car Company has 7 manufacturing divisions and subsidiaries located in Chicago, Buffalo, and Mt. Vernon, Ill. Behind them is over a half century of experience in the manufacture of light and heavy industrial equipment.

Interested?

Contact the Contract Sales Department of Pressed Steel Car Company *now*.

A PARTIAL LIST OF THE PRODUCTS WE CAN PRODUCE!

Aircraft Ground Servicing Equipment
Dollies-Engine, Propeller & Special Types. Stands—Maintenance, Servicing

Aircraft Component Parts
Containers—Ammunition; Equipment, Etc. Engine Mounts & Exhaust System Parts. Engine Shipping Containers

Communication Equipment
Chassis Metal Housings

Ordnance Equipment
Launchers Trailer Component Parts Trailers

Cellular Laminated Wood Structures
Shelters Trailers Containers

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Cellular Laminated Wood Products
From simple platforms and shipping containers to shelters and railroad cars.

PRESSED STEEL CAR COMPANY, INC.

Contract Sales Department

179 N. Michigan Avenue • Chicago, Illinois

Do your products use POWER SPRINGS?

Get DUAL POWER WITH SANDSTEEL "CROSSCURVED" SPRINGS

For longer lasting, smoother power delivery, investigate Sandsteel's DUAL POWER "crosscurved" mainsprings.

3 Easy Steps to Better Product Performance

1 **Send for Sandsteel's new brochure** — "Sandsteel Springs for DUAL POWER". 20 pages of useful information on power springs. FREE.

2 **Call on Sandsteel's free design service.** Our engineering facilities and quarter-century experience are at your disposal.

3 **Specify Sandsteel "crosscurved" springs.** Let our precision-made springs help make **your** product a **better** product.

SANDSTEEL SPRING DIVISION

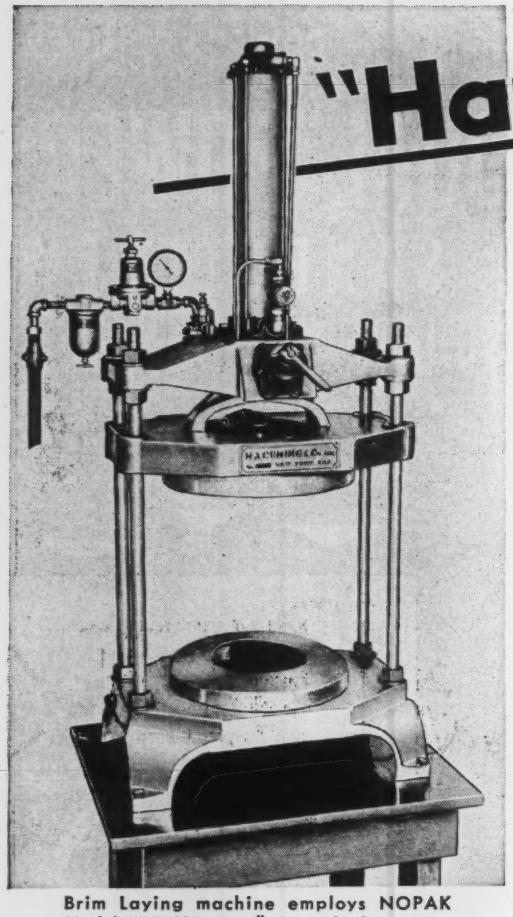
SANDVIK STEEL, INC.

145 HUDSON STREET, NEW YORK 13

Sandsteel Spring Division
Sandvik Steel, Inc.
145 Hudson Street New York 13, N. Y. Dept.10

Gentlemen: Kindly send, without obligation, a copy of "Sandsteel Springs for Dual Power."

Name.....Position.....
Firm Name.....
Firm Address.....
City.....Zone.....State.....



Brim Laying machine employs NOPAK Model "D" 2½ x 14" Air Cylinder.

"Hat Press" Operated by NOPAK Cylinder

The Cuming Pneumatic Brim Laying and Flanging Machine is used by leading makers of felt and straw hats to "set off" brims . . . formerly a laborious and highly skilled hand operation.

Controlled and cushioned NOPAK Cylinder Power results in faster closing, a shorter work cycle, constant and uniform pressure. This application may suggest similar uses for NOPAK Cylinders in the machines you build for others, or use in your own plant.

GALLAND-HENNING MFG. CO., 2752 S. 31st Street, Milwaukee 46, Wis.

NOPAK
VALVES AND CYLINDERS
DESIGNED for AIR and HYDRAULIC SERVICE

Write for Bulletin SW-1 or refer to Sweet's File for Product Designers.

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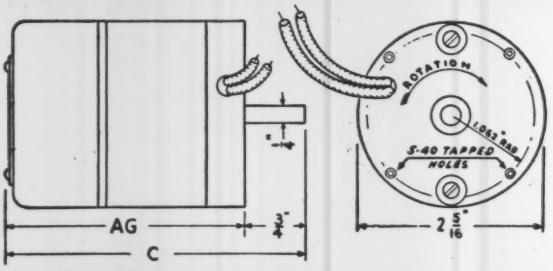
Representatives in Principal Cities

A 7174-½-HA

MANUFACTURERS OF ELECTRICAL PRODUCTS
SIGNAL'S
Special Design Motors

Example: type LD3 (illustrated) for aircraft



SPECIFICATIONS - Type LD3

VOLTS	CYCLES	AMPS	DUTY	H.P.	R.P.M.
24	DC	2.2	Intermit.	1/95	3600
24	DC	3.75	Intermit.	1/35	3600
24	DC	1.5	Cont.	1/100	4000
24	DC	7.8	Intermit.	1/8	8500

12-32 volts D.C. — With or without electrical Governor — Ball Bearings — Details on Request.

Facilities and assistance are available for the development of special motors, shaded pole, series or D.C. to meet given requirements.

Write, wire or call

SIGNAL ELECTRIC MFG. CO. • MENOMINEE, MICHIGAN

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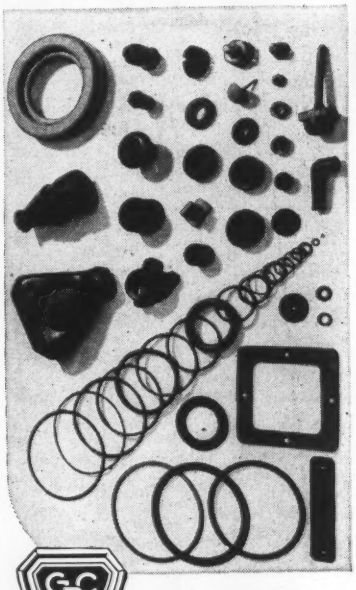
ask **GOSHEN** *about that*

RUBBER *notion*



If hydraulic or product design and improvement are your problems, let Goshen serve as your ONE dependable source for "O" Rings and mechanical rubber parts.

GRC "O" Rings are made to Air Force-Navy specifications, and for commercial use from silicone and other proven compounds to meet a wide range of conditions.

Laboratory and engineering facilities are at your service. Write for free GRC "O" Ring Catalog "C".

Goshen Rubber Company INC.
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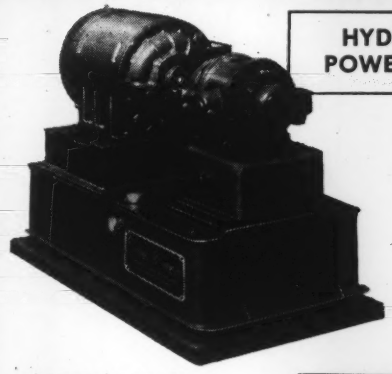
1762 S. TENTH ST. GOSHEN, INDIANA

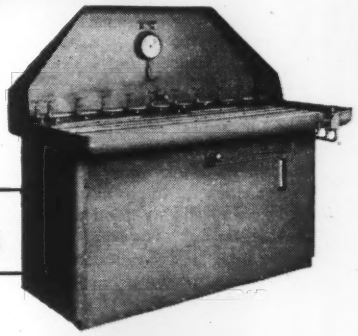
SUPERDRAULIC

PUMPS • VALVES • TRANSMISSIONS • REMOTE CONTROLS



HYDRAULIC POWER UNITS

ENGINEERING FABRICATING



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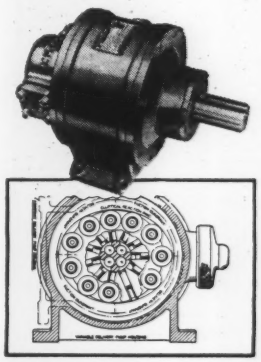
Let *SUPERDRAULIC* Engineers do the job for you

• Our specialized engineering and manufacturing knowledge is available to you for the designing and production of your power units and test stands. Superdraulic designs take into consideration every requirement and limitation of your job. Units can be furnished complete in every detail including motors, pumps, valves, reservoirs, etc.

***FAMOUS* SUPERDRAULIC HIGH PRESSURE PUMP**

Develops up to 60 H.P. at 5,000 P.S.I. Let us quote on your requirements.



Superdraulic CORPORATION

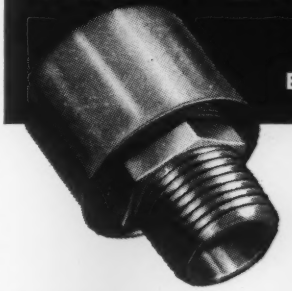
14256 WYOMING AVE. • DETROIT 4, MICH.

Bendix - Skinner

ORIGINATOR OF **MICRONIC** FILTRATION

offers **NEW** *Ribbon* **air vent filters**

IN SIZES FOR EVERY APPLICATION

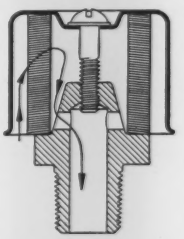


This compact, new ribbon element filter is available *for the first time* in three sizes—¼", ½", ¾" pipe thread, thus meeting the needs of every application.

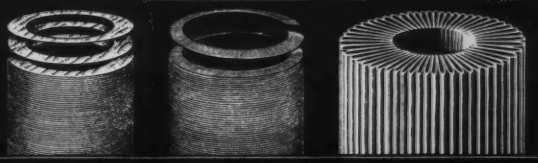
Positive Controlled Filtration. The specially designed element offers *greater efficiency than any air vent filter on the market*—approximately 40 micron filtration (.0016").

Lasts as Long as the Equipment. Although it costs little more than a quart of oil, *this ingenious filter will never wear out* . . . and is easily cleaned.

Hundreds of Uses. The new ***Bendix-Skinner*** Air Vent Filter has literally hundreds of applications. For example, hydraulic systems . . . air compressor intake . . . carburetor intake for small gasoline engines . . . crankcase ventilation . . . pneumatic cylinders . . . fuel tank breather . . . pneumatic instruments . . . immersion or sump filter.



Write Dept. B for complete details on this revolutionary new filter.



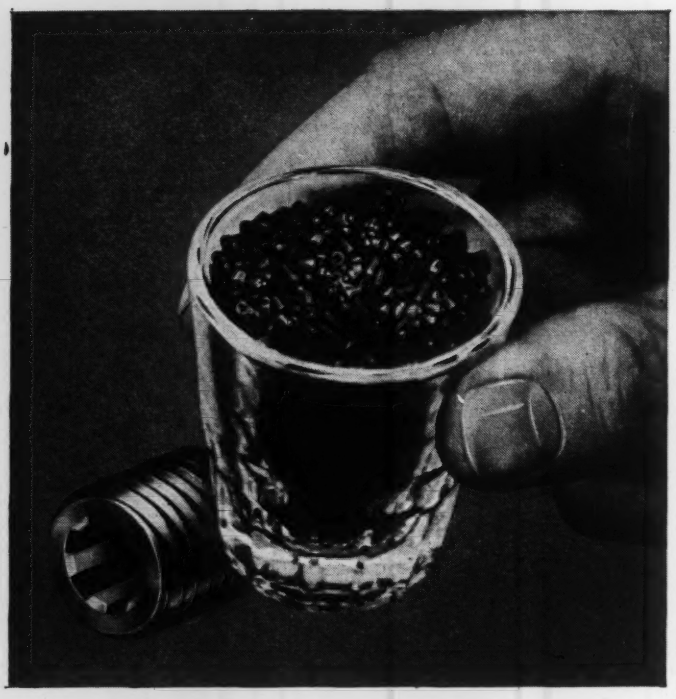
Disc-type Ribbon-type Pleated-type

SKINNER PURIFIERS DIVISION OF

1503 TROMBLY AVENUE, DETROIT 11, MICHIGAN

Bendix AVIATION CORPORATION

Export Sales: Bendix International Division, 72 Fifth Ave., N. Y. 11, N. Y.



Proof of Precision

that means tighter fastening!

See the unique multiple-spline socket in that large 1-inch Bristol Socket Screw.

You'll find this same exclusive Bristol feature (vital to *tighter* tightening) in every one of the 7,438 tiny No. 0 Bristol Socket Screws held in that 2 oz shot glass.

It takes precise machinery . . . painstaking effort . . . to make them that way. But it's worth it . . . to give you shock-resistant fasteners, precise enough to be used in electric razors, cameras, communications devices, instruments of all kinds.

The multiple-spline socket permits tightening beyond limit of ordinary screws . . . turns internal wrenching force into *rotary motion*, not expanding pressure. Hence, no bursting, no rounding out of socket walls—even in sizes down to No. 3, 2, 1, 0 wire size. *Result:* maximum resistance to vibration.

Other advantages: ideal for compact assemblies and hard-to-get-at fastening points. For disassembly, a reverse flick of wrench loosens the set.

Only BRISTOL *gives you the right socket screw for every application*

BRISTOL'S

Multiple-Spline and Hex Socket Screws...Cap and Set

SEND COUPON FOR FREE SAMPLES
—also helpful bulletins on designing compact, tight assemblies.

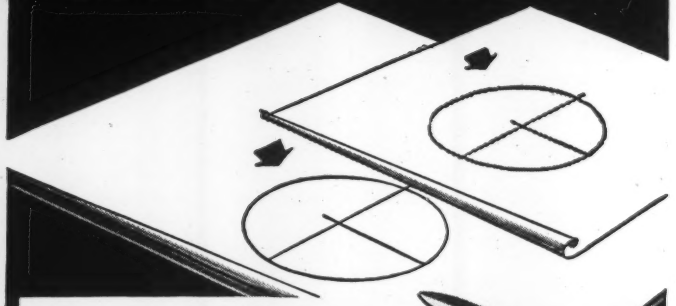
The Bristol Company
Mill Supplies Division
122 Bristol Road, Waterbury 20, Conn.

Please send me free sample of Bristol's Multiple-Spline Screw and bulletins showing applications to:

NAME_____ TITLE_____
COMPANY_____
ADDRESS_____
CITY_____ ZONE_____ STATE_____
Screw Sizes_____
Our problem is mainly_____ VIBRATION ☐
COMPACT DESIGN ☐ FREQUENT TAKE-APART ☐

Imperial

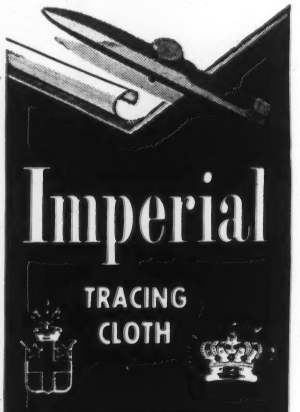
TRACING CLOTH THAT DEFIES TIME



• The renown of Imperial as the finest in Tracing Cloth goes back well over half a century. Draftsmen all over the world prefer it for the uniformity of its high transparency and ink-taking surface and the superb quality of its cloth foundation.

Imperial takes erasures readily, without damage. It gives sharp contrasting prints of even the finest lines. Drawings made on Imperial over fifty years ago are still as good as ever, neither brittle nor opaque.

If you like a duller surface, for clear, hard pencil lines, try Imperial Pencil Tracing Cloth. It is good for ink as well.



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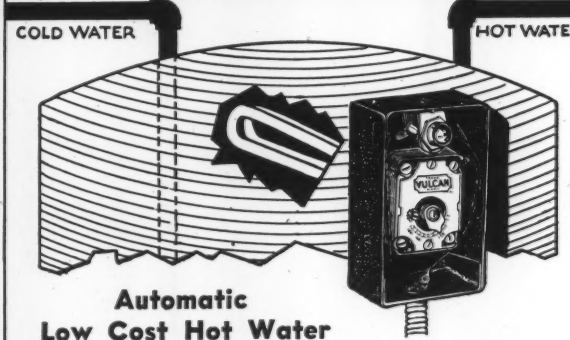
VULCAN

ELECTRIC IMMERSION *Thermostat Control* HEATERS



Automatic
Low Cost Hot Water

for factories, stores, offices, laboratories, stock rooms, etc. Packaged unit includes thermostat, pilot light and switch.

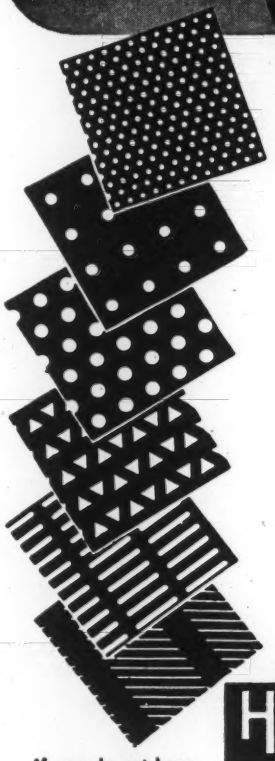
Simply screw in tank through 1" threaded flange, connect to AC power and set thermostat for desired temperature.

Special types for heating oils, chemicals and other liquids.

VULCAN ELECTRIC COMPANY
DANVERS 6, MASS.

Vulcan Electric Heating Units, Soldering Tools, Solder Pots, Glue Pots, Branding Irons.

H & K PERFORATED MATERIALS offer you . . .



AVAILABILITY
H & K is prepared to perforate metal, plastic, fabrikoids, masonite, plywood and many other materials available in sheet, plate or coil form—in thicknesses from tissue thin to 1" steel.

PATTERNS
A wide selection of patterns are available in standard round, square, slot, oblong, triangular holes and also special holes such as indented, lipped, burred, tapered, stabbed, etc.

ACCURACY
Hole sizes can be held to a tolerance of ± .0005" when required. Holes are accurate and uniform in size, shape and spacing.

OPEN AREA
Various spacings and arrangements of our perforations provide wide range from which to select a required percentage of open area.

SURFACE
Smooth and easy to clean.

Send us your specifications for recommendations without obligation.

The Harrington & King PERFORATING Co.

If you do not have H & K Catalog #62 —write for it!

5670 Fillmore St., Chicago 44, Illinois
114 Liberty St., New York 6, N. Y.

STANDOUT IDENTIFICATION *– at the right price!*

METAL NAME PLATES by

CHICAGO THRIFT-ETCHING CORPORATION

Spotlight your product with a sparkling metal name plate that reflects quality, lends distinction and assures permanent readability. Ask us to quote on name and instruction plates, dials, panels, etc. We also apply special finishes to aluminum products and parts including ANODIZING by the exclusive Alumilite process. Write today for information and quotations.

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SUBSIDIARY OF DODGE MFG. CORPORATION, MISHAWAKA, IND.

High Pressure SOLENOID VALVES . . .

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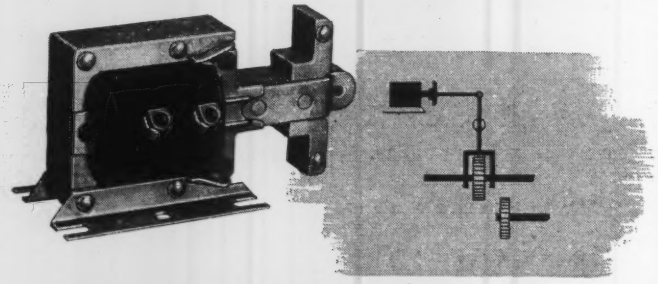
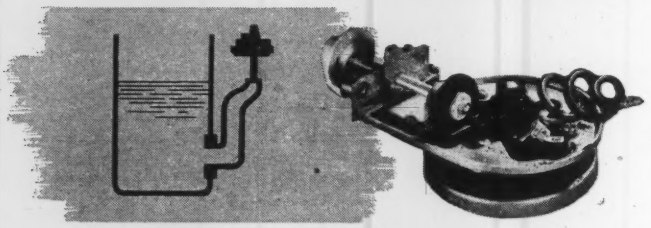
WATERMAN Engineering Company
725 CUSTER AVENUE — EVANSTON, ILL.

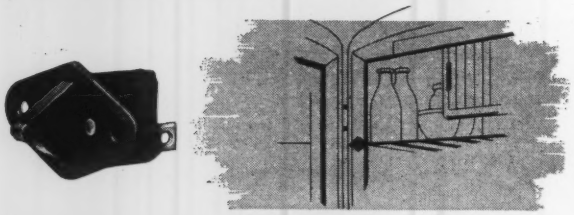
Custom-Engineered-Custom-Made
to your application

SORENG ELECTRICAL SPECIALTIES

Production-engineered to assure top quality at low cost







Custom-made components at production-line prices. Isn't that what *you* want? Then look to Soreng for quality electrical specialties—for both defense and civilian production.

Soreng Solenoids, Switches, Terminals and other components are expertly engineered and manufactured to *your specific* application. That means they do a *better* job throughout a *longer* service life. Strict quality control and mass production are your assurance of *dependable* components at *competitive* prices.

So why not see for yourself what Soreng can do for *you*—on both your regular and defense work. Your inquiry will receive prompt attention—without obligation. Please address Dept. C26.

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Plants: Schiller Park, Ill. • Fremont, Ohio

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SET SCREWS
to solve ALL problems

for REGULAR Set Screws

SETKO socket and slotted SET SCREWS

For the past 17 years, we have furnished billions of set screws to satisfy the requirements of nearly 1300 different manufacturers.

If size, special head or point, price or delivery are your problems, send for our Catalog. It illustrates and describes set screws, headless or with various type heads and points in all materials.

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SELF-LOCKING SET SCREWS During the past year, more than 130 makers of everything from radios to washing machines, from pumps to power mowers have solved problems like yours with ZIP-GRIP.* *PAT. PENDING

Send for FREE DEMONSTRATOR —that demonstrates ZIP-GRIP's* three-way Self-Locking effect.

We'll also include illustrated Data Sheet and offer of Test Samples to fit your application. Send now.

Set Screw & Mfg. Co.
28 Main St. Bartlett, Ill. (Chicago suburb)

We specialize in Solving Puzzling Set Screw Problems.

5912

Q Can Aluminum be PLATED?

A Yes—SEE ALCOA. Alcoa's finishing laboratories are continually improving and developing finishes for aluminum—painted, electroplated, anodized plus chemical and mechanical treatments. For the latest information, simply write on your company letterhead to:

ALUMINUM COMPANY OF AMERICA
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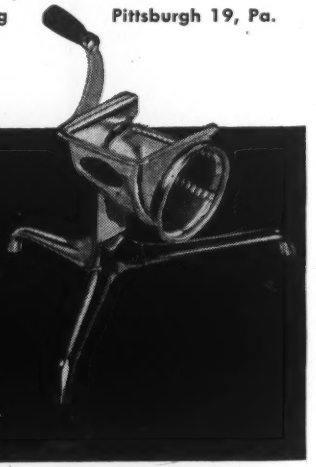
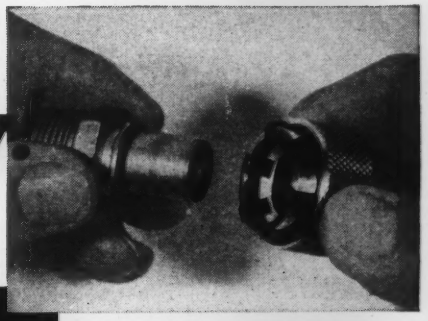
SALADMASTER
—made by Kitchen Quip, Inc.
finished by Imperial Plating & Metal Finishing Inc.



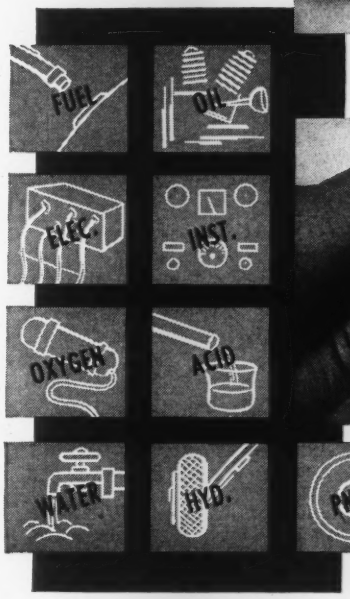
ALCOA
ALUMINUM COMPANY OF AMERICA

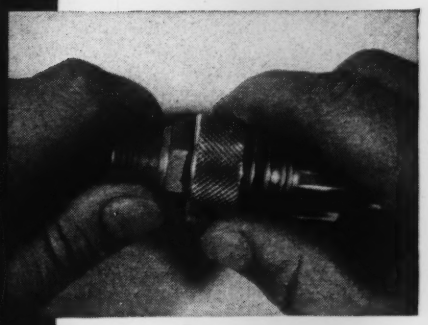
Throw your wrench away

CONNECT or DISCONNECT any fluid or electric line *without a wrench*



PULL and the mating halves disconnect.





PUSH and the mating halves connect. Especially useful in hard-to-get-at places.

Wherever fluid or electrical lines must be joined or separated easily and quickly, you can rely on *WIGGINS Inst-O-Matic couplings.* No wrench; just use your fingers.

If you use couplings on fuel, oil, hydraulic, electrical, pneumatic, oxygen, acid or water lines, you can use this cost-cutting coupling.

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Aircraft Division
E. B. WIGGINS OIL TOOL CO. Inc.
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SUBMIT YOUR PROBLEM

WIGGINS Inst-O-Matic couplings can reduce your costs. Write today. There's a qualified representative near you.

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Mayline has outstanding straightedges. The Mobile model has retractile rollers on the under side of the blade. This straightedge rolls over your drawing. It merits your further investigation.

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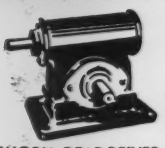
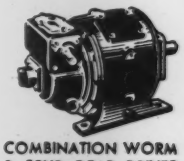
You can meet your exact requirements for each specific application with one of the more than 75 Abart Speed Reducer Models available. Whatever the required input or output—whether you need a single or double reduction—there's a "just-right" unit to give you years of trouble-free service. Ratings from 1/50 to 168 h.p., ratios to 10,000 to 1.

★ *Send today for handy "Pocket-Size" catalog of Abart Speed Reducers*



WORM GEAR DRIVES

SPUR GEAR DRIVES



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Abart GEAR & MACHINE CO.
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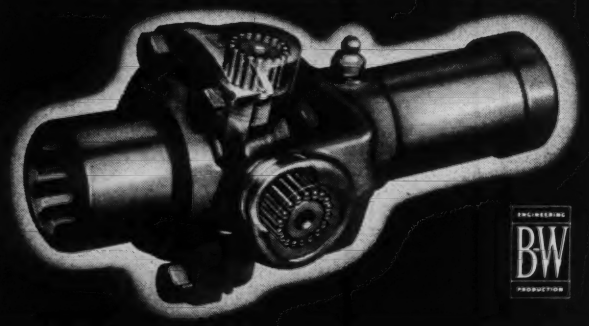
Mfrs. of Gears and Speed Reducers

A SIZE AND TYPE FOR EVERY USE



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For Cars · Trucks · Busses and Industrial Equipment

MECHANICS makes the most complete line of SIZES and TYPES of Roller Bearing UNIVERSAL JOINTS — for every application. Sizes range from 200 to 50,000 foot pounds torque, with a wide variety of end connections and shaft arrangements. Millions of cars, trucks, buses, tractors, farm, construction and industrial machines, and aircraft of all types benefit from design and manufacturing advantages of MECHANICS (Lifetime or Once-a-Season Lubricated) Roller Bearing UNIVERSAL JOINTS. In addition to conventional applications, we make joints for steering columns, etc. Our new catalog — showing the complete line of MECHANICS Roller Bearing UNIVERSAL JOINTS will be sent to manufacturers, upon request.

MECHANICS UNIVERSAL JOINT DIVISION

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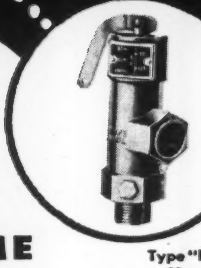
CASH-ACME *Valves* DEMANDED BY INDUSTRY *Everywhere*



water heater manufacturer specifies CASH-ACME

Type "RH-TL" Revolving Head Relief Valve

Convinced of CASH-ACME Automatic Valve quality and consistent performance under pressure, one of the largest manufacturers of automatic hot water heaters installs this better relief valve on all their products. It protects them, it protects their customers when CASH-ACME is on the job. Let us tell you about the growing number of industries depending on CASH-ACME. Write for literature describing the part CASH-ACME Automatic Valves can play in the successful operation of your products.

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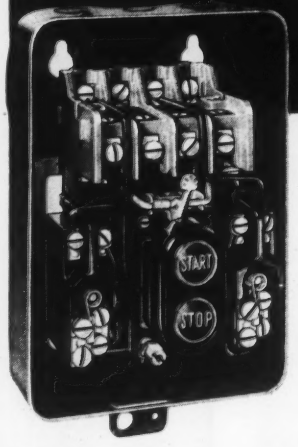
Decatur, Illinois

5 *Reasons* FOR DEMANDING FURNAS *MAGNETIC STARTERS*



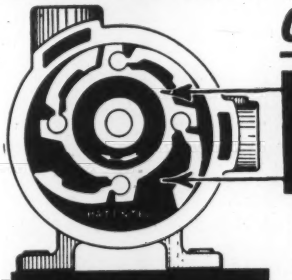
Furnas Magnetic Starter rated 5 hp. 220v; 7½ hp. 550v AC.

Write for catalog 50A to Furnas Electric Company, 1045 McKee St. Batavia, Ill.

1. **ARC-QUENCHING SILVER CONTACTS** — Rigidly tested and selected for low contact resistance, best arc-quenching properties.
2. **ARC-RESISTANT TERMINAL BOARD** — Molded of plastic selected for non-tracking properties.
3. **DUAL VOLTAGE COILS** — Furnished in both polyphase and single phase starters.
4. **POSITIVE ACTING THERMAL OVERLOAD UNITS** — of solder-pot type automatically protect motor from overheating.
5. **SHALLOW CASE FOR EASY WIRING** — and good visibility.

FURNAS *Electric* MOTOR CONTROLS

LEIMAN AIR PUMPS give you *Greater Capacity!*



SMALLER PISTONS *provide* LARGER AIR SPACE

HINGED WINGS
take up their own wear

Compare this cross-section of a Leiman Air Pump with any other rotary air pump. It is working air space that counts—and Leiman provides 2 to 3 times more area, per size and weight of pump.

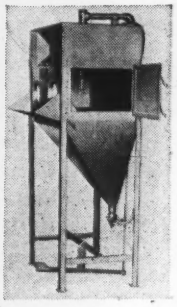
Handle your pressure, vacuum or suction jobs with much smaller Leiman Air Pumps. Save weight and space—have fewer moving parts—no springs, gaskets or packing—no tips to renew—nothing to give trouble.

What is your air application? Send us details. Leiman engineers offer over 60 years' experience with thousands of air applications. Catalog and Application Data sent on request.

For Pumps—write DEPT. A

Metal Cleaning and Finishing without acids or scratch brushes

LEIMAN SANDBLASTS



Fast, low-cost, safe, uniform way to clean scaly, rusty, rough surfaces—prepare for plating and finishing—stencil letters and designs—more rapid matte or satin finishes. Use unskilled help.

For Sandblasts—write DEPT. B

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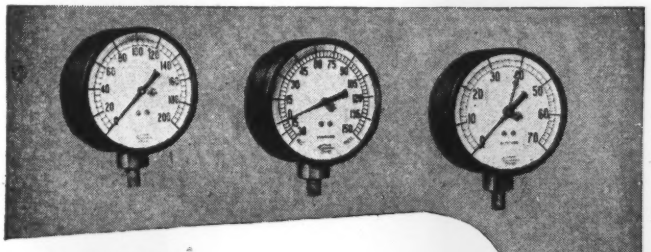

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The combinations of styles, types, mountings, ranges and functions of Marsh Gauges are almost endless; but they all have one trait in common: Each is best for the service for which it is recommended. Write today for the new Marsh Catalog covering the broad Marsh line. Let us prove that Marsh is the gauge for your product, whether you need a few or thousands.

Marsh Instrument Co.
Sales affiliate of
Jas. P. Marsh Corp.
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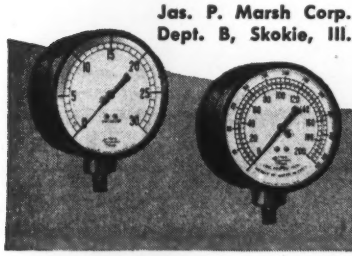

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BEARING PERFORMANCE

Cut maintenance costs...
Reduce shutdown time...
Increase production...

MORGANITE
SELF-LUBRICATING
CARBON BEARINGS

APPLICATION: Extensive—from food machinery and guided missiles, to household appliances and steel mill equipment.

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CHARACTERISTICS: Self-lubricating action is derived from the inherent nature of the material. Thus will not warp, contaminate or impart taste or odor. Unaffected by high temperatures.

ECONOMY: Morganite is self-polishing and self-lapping, eliminating costly finishing.

Call or write for recommendations on specific problems, or request illustrated literature. See our bulletin insert published in Sweets Product Design File for further details.

see our CATALOG in SWEET'S FILE

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Manufacturers of CARBON SPECIALTIES, MOTOR and GENERATOR BRUSHES and CARBON PILES

FAST WORK!

WITH GRIPCO LOCK NUTS

APPLIED FAST!

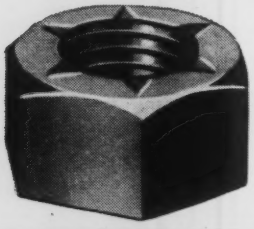
Gripco Lock Nuts are started on the bolt threads *fast* just like a common nut.

LOCK FAST!

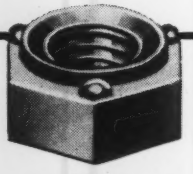
When the Gripco deflected threads contact the bolt threads, the nut is seated *fast* and locked with a wrench.

HOLD FAST!

Until it is removed with a wrench. *Gripco Lock Nuts* can be removed and reapplied many times without appreciable loss of locking effectiveness.

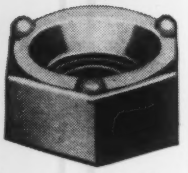


GRIPCO LOCK NUT
makes the Bolt-Thread End as secure as the Head End.



GRIPCO PILOT-PROJECTION WELD NUTS

Also *applied fast.* The pilot positions the nut quickly and accurately, and it is instantly attached by resistance welding.



GRIPCO COUNTERSINK WELD NUTS

Weld Fast! The slanting "countersink" section catches loose metal particles and slides them down the slanting "countersink" surface away from the threads. No re-threading required!

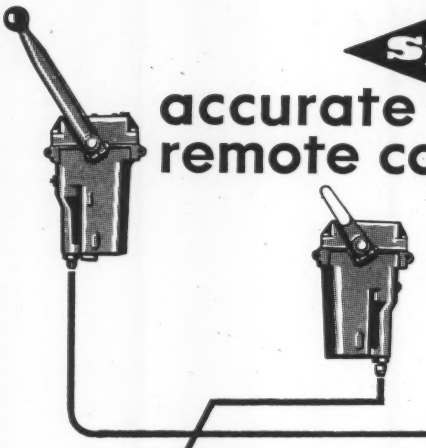
GRIPCO WELD NUTS *are furnished with either lock or plain threads.*

5850

GRIP NUT COMPANY
310-W S. Michigan Ave., Chicago, Illinois

Sperry

accurate remote control



A self-contained, hydraulic control, that delivers immediately to the receiver any force applied to the transmitter. Being completely independent of outside sources of power and due to the incompressibility of the hydraulic oil, the Sperry Remote Control System assures instantaneous precision operation of a remote mechanism.

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REPRESENTATIVES IN PRINCIPAL CITIES

FOR *Quality Performance* from

SPRINGS
WIRE FORMS
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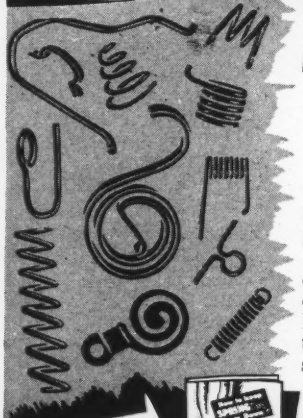

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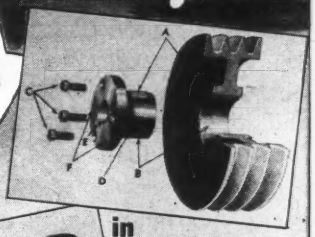
BROWNING

First Again!

WITH "UNBREAKABLE" MALLEABLE IRON SPLIT TAPER BUSHINGS



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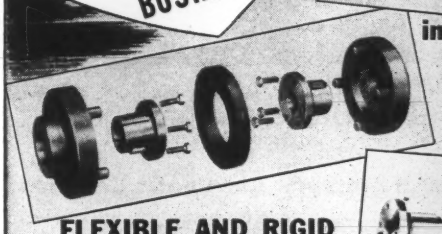
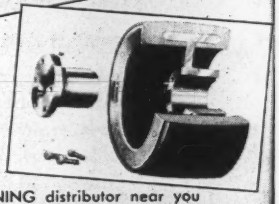
BROWNING GRIPBELT SHEAVES



FLEXIBLE AND RIGID COUPLINGS and BROWNING PAPER PULLEYS



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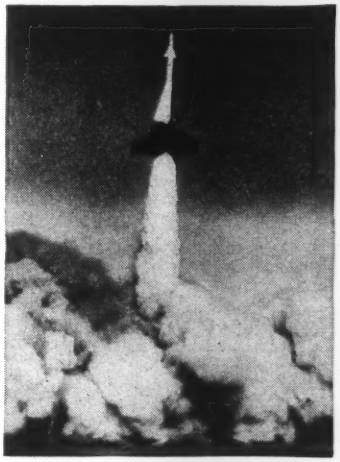
BROWNING MANUFACTURING COMPANY

MAYSVILLE, KENTUCKY, U. S. A.

For ultra precision design

specify Micro, America's only fully ground miniature ball bearings



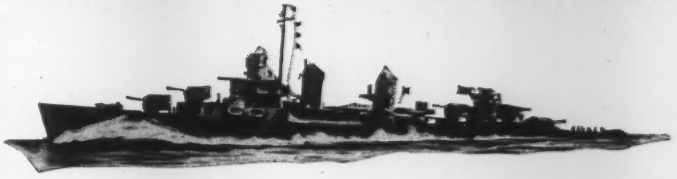
In just three years, sales of Micro bearings have soared 850% as more and more top-flight designers and engineers choose Micro for exacting designs. Only *grinding* can give you the ultra precision and trueness of dimension Micro offers — yet Micro bearings actually cost less than unground miniatures. 85 sizes and types in dimensions as small as 1/8" o.d. and in tolerance ranges of ABEC-5 and above.

Write for Technical Bulletin No. 50

New Hampshire MICRO **Ball Bearings, Inc.**

12 Micro Circle, Peterborough 1, N. H.

Whether it's a DESTROYER



. . . or a DINGY

FRONTIER 40-E ALUMINUM ALLOY

HELPS GIVE THEM Seagoing Strength

Whether it's used on land, sea, or air . . . whether it's used in radar equipment, oar locks or deck cleats . . . on trucks, "jets", or ships, FRONTIER 40-E Aluminum Alloy castings have the essential properties to do a better job. Here's an alloy that has machineability, shock and corrosion resistance, pressure tightness, high yield strength and extremely light weight all rolled into one rugged alloy. It needs *no heat treatment* and is as ideal for precision parts as it is for heavy-duty truck axles. Find out how many different jobs FRONTIER 40-E is ready to do for *you.*

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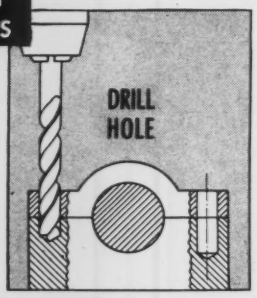

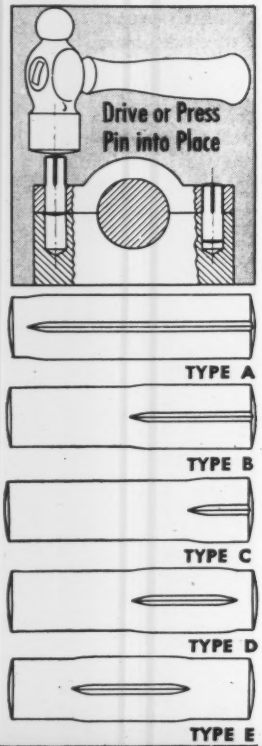

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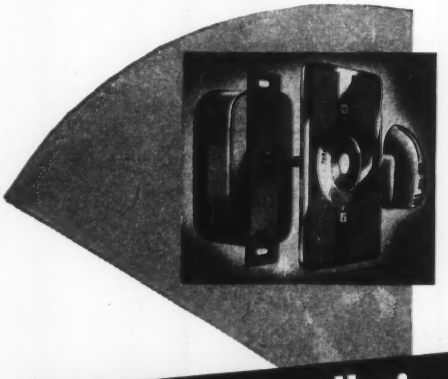

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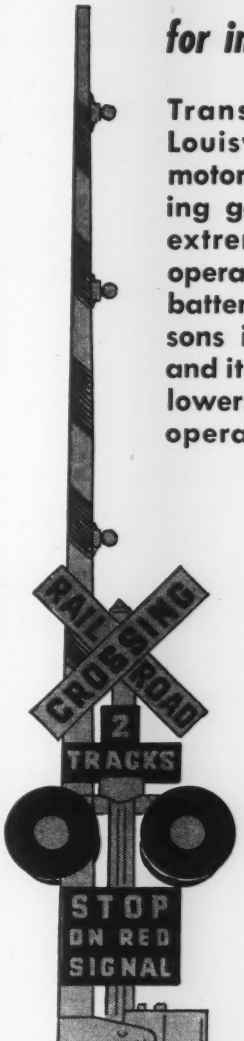

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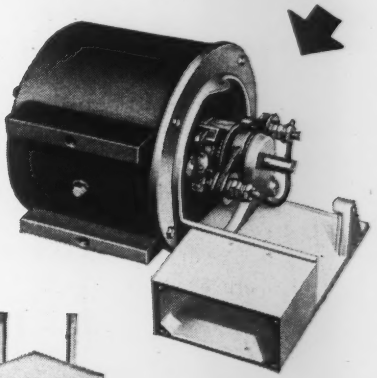

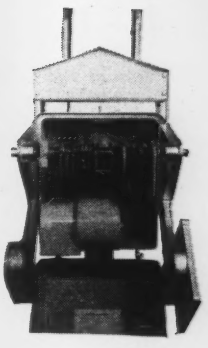

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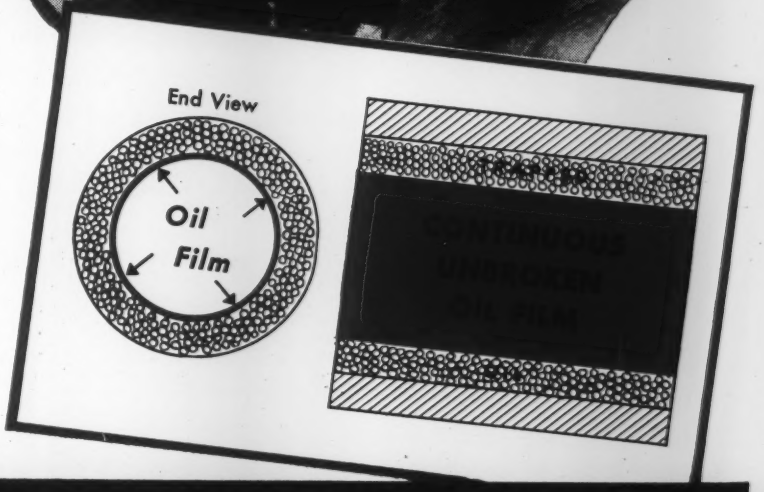

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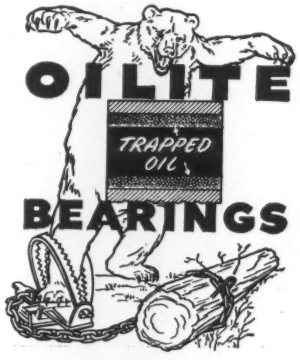

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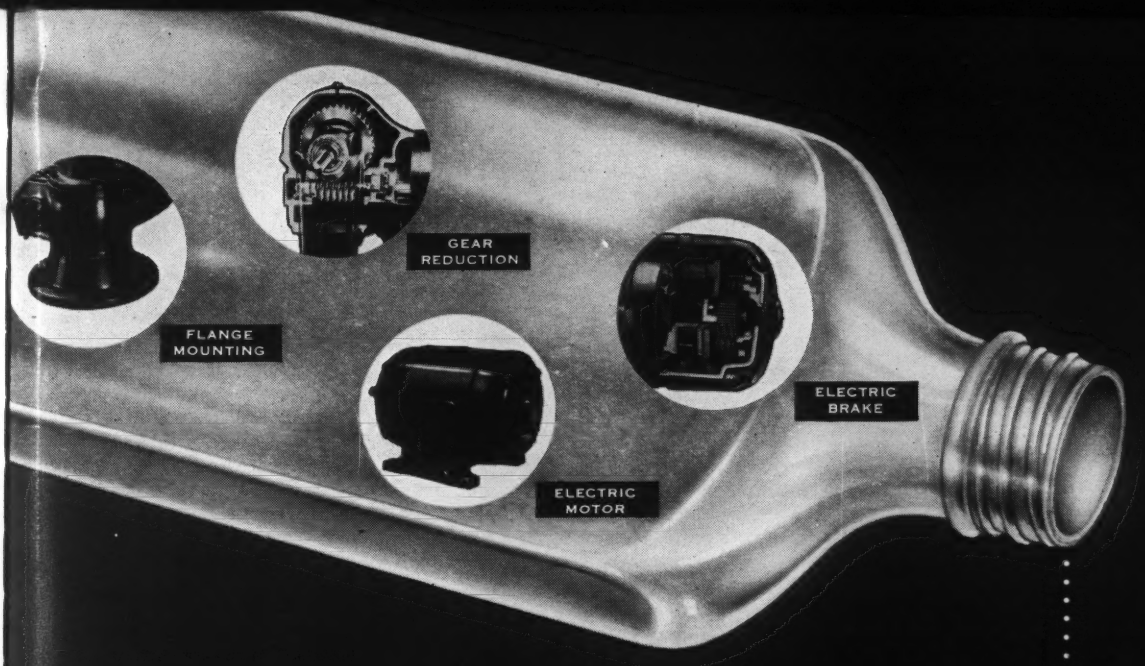

There's no one cure-all

Each case is different. But you can select from Masters broad line the correct combination of features to give you the RIGHT horsepower, the RIGHT shaft speed, the RIGHT construction features, the RIGHT mounting . . . all combined into one compact power package.

Master Motors, available in thousands and thousands of types and ratings (⅛ to 200 HP) give you a breadth of selection you can get nowhere else. Master engineers can be completely impartial in helping you select the one best drive for you.

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MASTER ELECTRIC MOTORS

Table of 42-ft. boring mill is centered on TIMKEN® bearings; runs true within .001"

THIS giant Consolidated vertical boring and turning mill is one of the world's largest. Its 20-foot table weighs 60 tons—can take a work piece up to 42 feet in diameter weighing 82 tons! Its table runs true within one thousandth of an inch!

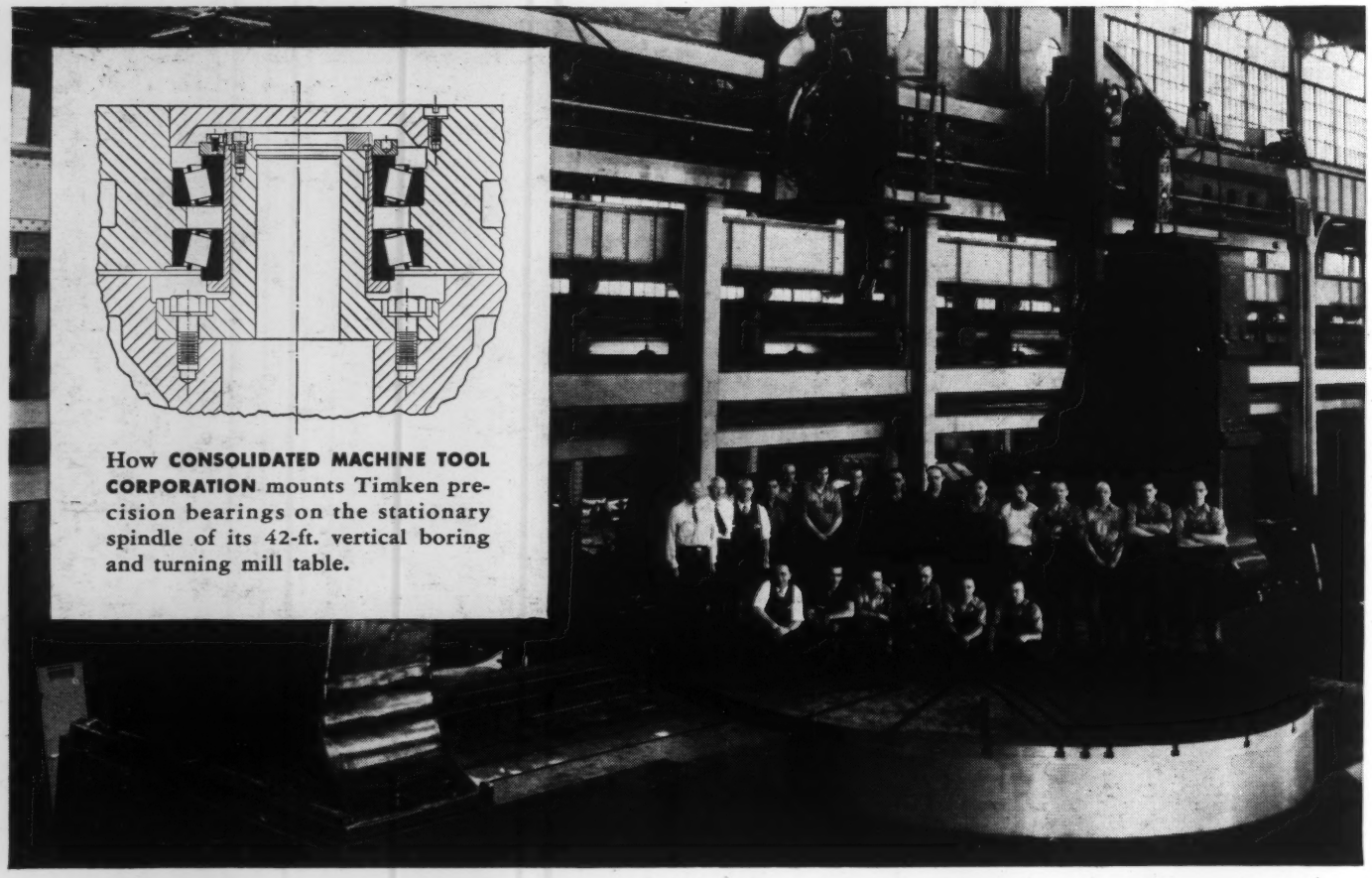
To make this amazing precision possible, Consolidated uses Timken® tapered roller bearings on the table centering spindle. These precision Timken bearings have high load carrying capacity resulting from line contact between rollers and races. Their tapered construction permits preloading. The result: deflection is minimized, long lasting accuracy is assured.

To help turn the total 142-ton load smoothly, Timken bearings are also used in the drive. They hold shafts in alignment, insuring accurate gear mesh, longer gear life.

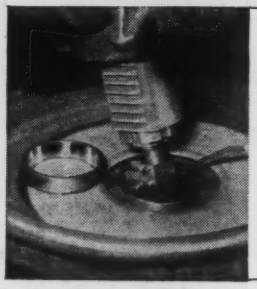
Due to the ease with which Timken bearings can be set up, manufacturing costs are reduced. Auxiliary thrust bearings are eliminated, table maintenance is simplified.

No other bearing can offer you all the advantages of Timken bearings. Look for the trade-mark "Timken" on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ont. Cable address: "TIMROSCO".

This symbol on a product means its bearings are the best.



How **CONSOLIDATED MACHINE TOOL CORPORATION** mounts Timken precision bearings on the stationary spindle of its 42-ft. vertical boring and turning mill table.



FINISHED TO CLOSER TOLERANCES

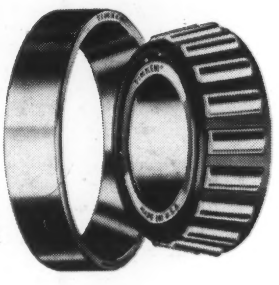
Finishing to incredible smoothness accounts for much of the precise, smooth rolling performance of Timken bearings. This honing operation is typical of the amazingly accurate manufacturing methods at the Timken Company.

The Timken Company is the acknowledged leader in: 1. advanced design; 2. precision manufacturing; 3. rigid quality control; 4. special analysis steels.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS



NOT JUST A BALL ○ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ◎ AND THRUST →◎← LOADS OR ANY COMBINATION